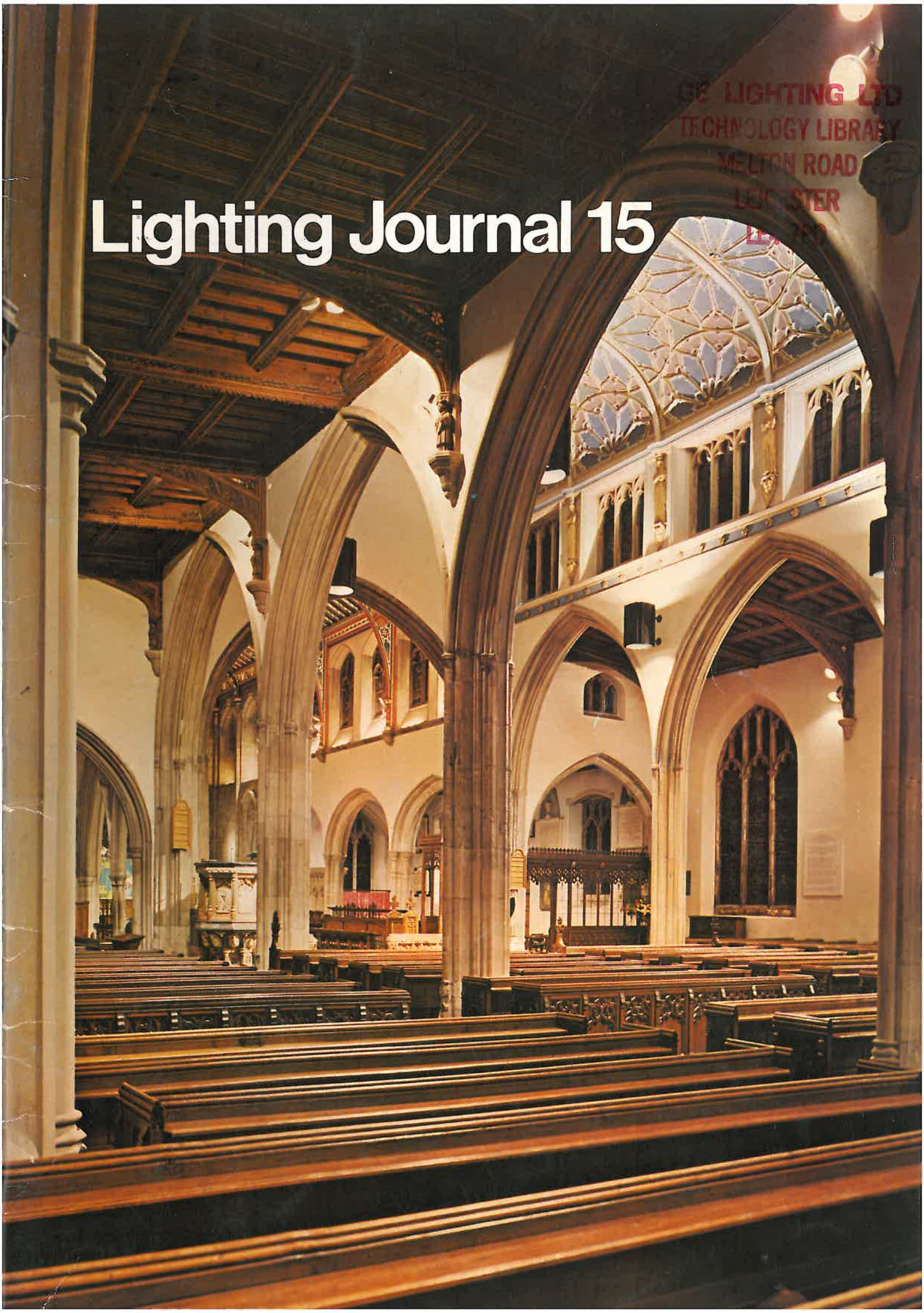
Lighting Journal 15



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Special floodlighting for the CIE meeting in London Last year included the York Water Gate in the Embankment Gardens. Mercury and tungsten halogen lamps were used to light the front elevation and blue Color-Ray PAR lamps were installed inside the arches to simulate reflections from the water.

Lighting Journal 15

Spring 1976

Editor R L C Tate
Editorial Board
A H Nash R E Allen M A Cayless
R C Kember W K Lumsden
A M Marsden C H Phillips

In this issue of *Lighting Journal* the importance of basic research is clearly stated in the article on the work of the new laboratories at Enfield contributed by Mr Willoughby and the two articles on lamp technology towards the end of the journal, while other articles deal with a number of practical installation problems. Examples of energy conservation brought about by replacing obsolescent or heavily polluted lighting equipment by more efficient lamps and reflectors include the use of SON TD lamps in Haline floodlights in the gigantic new rolling mill at Thrybergh, near Rotherham, which has just been put into commission by the British Steel Corporation.

How Thorn's lighting activities range over the world is emphasized by reports of installations as far north as Trondheim and south as Dunedin. The description of the lighting of the Stockholm Underground, with its emphasis on the aesthetic treatment of stations hewn from the solid rock, highlights the very efficient way in which Thorn Belysning sets about its lighting problems.

A very up-to-date German Bank is contrasted with a masterpiece of the renaissance in Venice — both are lighted by equipment made in England by Thorn Lighting Limited, and we strike an antiquarian note in the lighting of the curious game of Real Tennis; still played as it was four hundred years ago by Henry VIII — but in a far better light.

Some changes have taken place in the Editorial Board. Mr R E Allen who has been most helpful in contributing matter from Thorn Overseas, joined it last year. This year we welcome Mr Ken Lumsden, whose knowledge of Thorn activities in the installation field is already making itself felt and Dr M A Cayless who has contributed an article in this issue and has taken the place of Mr D T Waigh, now commencing a very busy retirement. Being a member of the Editorial Board is no sinecure and the Editor is very grateful for the help and guidance he receives from its members.

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Our cover picture shows the nave of Chelmsford Cathedral, seen from the outer north aisle. Standard lighting equipment is mounted behind roof members etc to light the aisles. Parts of the nave roof can also be seen.

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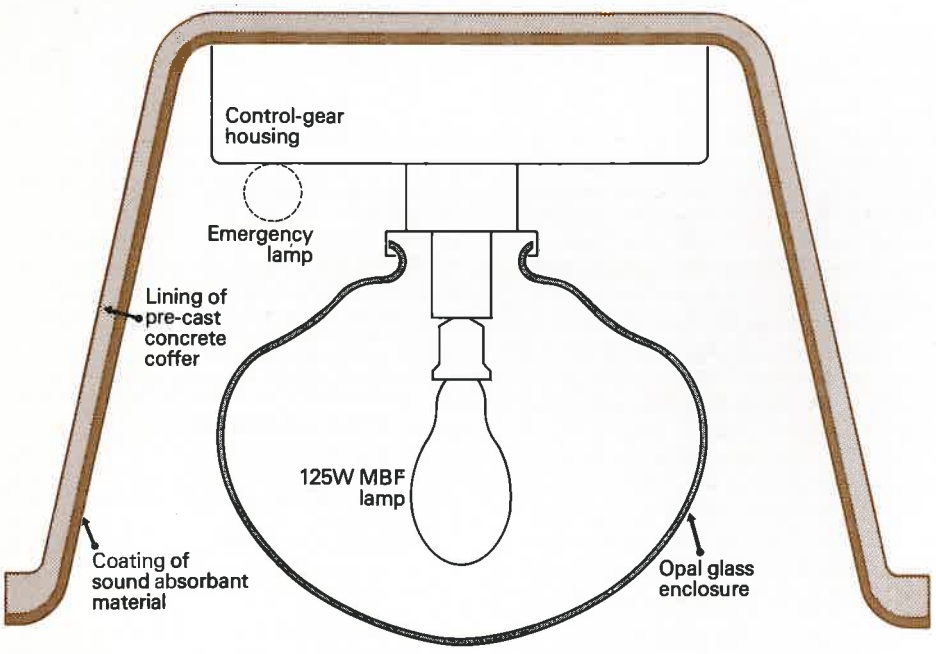
Two Unusual Installations

I F McLean and R C Aldworth



Top: This general office at the Metal Box Headquarters at Reading is lighted by 125W MBF lamps in specially designed diffusers mounted in the structural ceiling coffers.

Above: A section through a ceiling coffer, showing the MBF lamp in its glass diffuser and the emergency lighting system.

Mr Maclean is a senior project engineer at Thorn Lighting's London office, Mr Aldworth is Senior Lighting Engineer, Thorn Lighting.

The Metal Box Company

The floors of the Metal Box Company's office building are constructed of prefabricated concrete boxes, about two feet square and eighteen inches deep, joined together to form a deeply coffered ceiling, in a very strong light-weight construction. The architect envisaged special lighting fittings mounted within some of these coffers, so that coffer and luminaire would become a single lighting unit.

The architect's design called for luminaires in which 85W or 125W MBF lamps are housed in opal glass bowls. These bowls were specially made by the famous glassworks of Flygors in Sweden and were rigorously tested to withstand the thermal and mechanical shock of a lamp exploding. Photometric, heating and mechanical tests were carried out in Thorn's Enfield Laboratories with the luminaires mounted within the precast coffers in which they would be used. Heat tests were made in accordance with BS 4533 on thirty or forty points on their surface, and photometric tests showed a LOR of 52% and BZ rating of 5, for the complete assembly.

The layout of the scheme was determined by the consultants, a planned illuminance of 500-700 lux being achieved with the rather high calculated glare rating of 22.

In spite of the high glare rating, perhaps because very little of the luminous area of the fittings appeared below the coffers, or because the IES glare system does not apply to coffered ceilings, very comfortable working conditions have been achieved. The use of the structural ceiling coffers not only gives an interesting pattern of light and shade but also relieves the monotony of the very large office areas.

Approximately one in ten luminaires are fed from a separate emergency lighting circuit. In the case of mains failure they are automatically switched over to an auxiliary alternator. To avoid total darkness before the mercury lamps restrike, these luminaires are provided with a 60W tungsten lamp operated by a hold-off relay across the ballast of the discharge lamp that switches off the filament lamp when the other has run up.

The architects were Llewlyn Davies, Weeks, Forrester-Walker and Bor, the mechanical and electrical consultants Dale and Ewbank, the main contractors G. Wimpey and Son and the electrical contractors N. G. Bailey of Bradford.

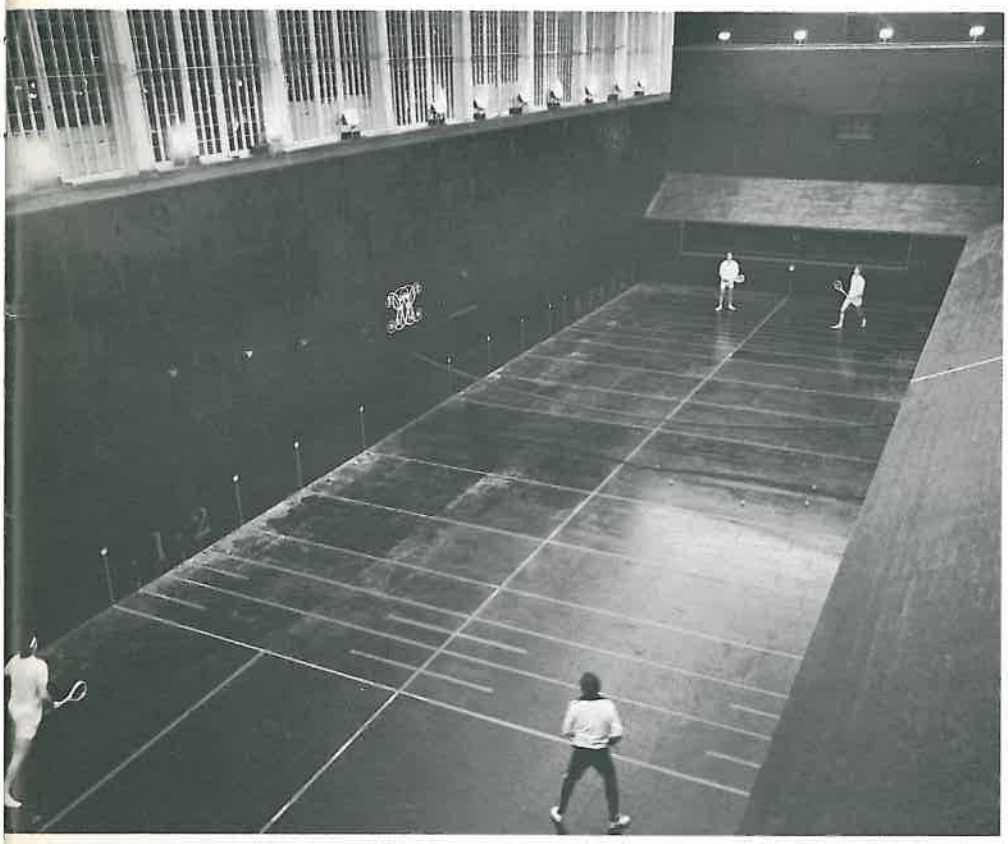
Below: A general view of the Royal Tennis Court at Hampton Court, where Real Tennis has been played since 1530. The black painted walls and floor presented great difficulties for the lighting engineer.

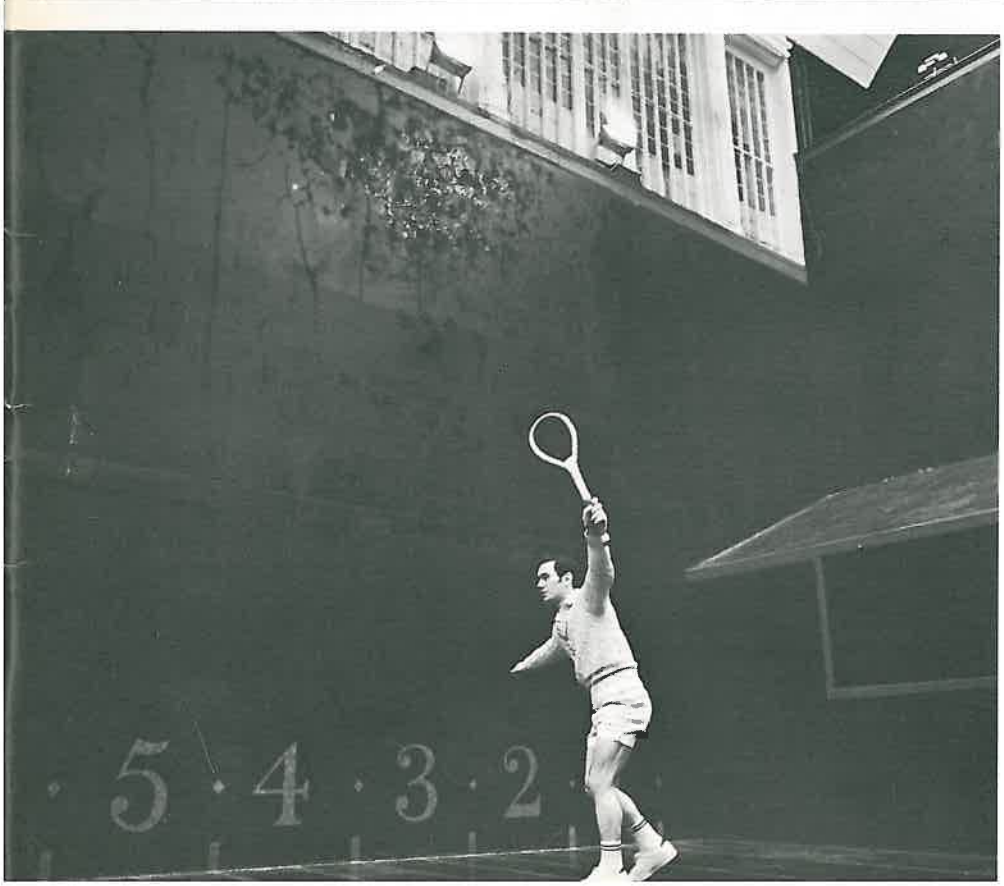
Bottom: The reigning champion of Real Tennis. Note the excellent definition of the archaic racquet.

An ancient sport with a modern source

Real Tennis probably originated in French monasteries during the 11th and 12th Centuries and the court still bears a resemblance to the cloister garths where it may first have been played. The court area is approximately 27m x 9m (a lawn tennis court is 24m x 11m) and along one side and the two ends is a structure with sloping "cloister roof".

There are only 14 courts in Great Britain and another 12 overseas which cater for this minority sport. One of these is the Royal Tennis Club at Hampton Court which was built by Henry VIII around 1530 and is claimed to be the oldest ball game court in the world which is still in regular use. The floor, roof and walls up to a height of 6m are black with windows on both sides above this level running the full length of the building. The flat ceiling is approximately 10m above the court and is painted matt white.





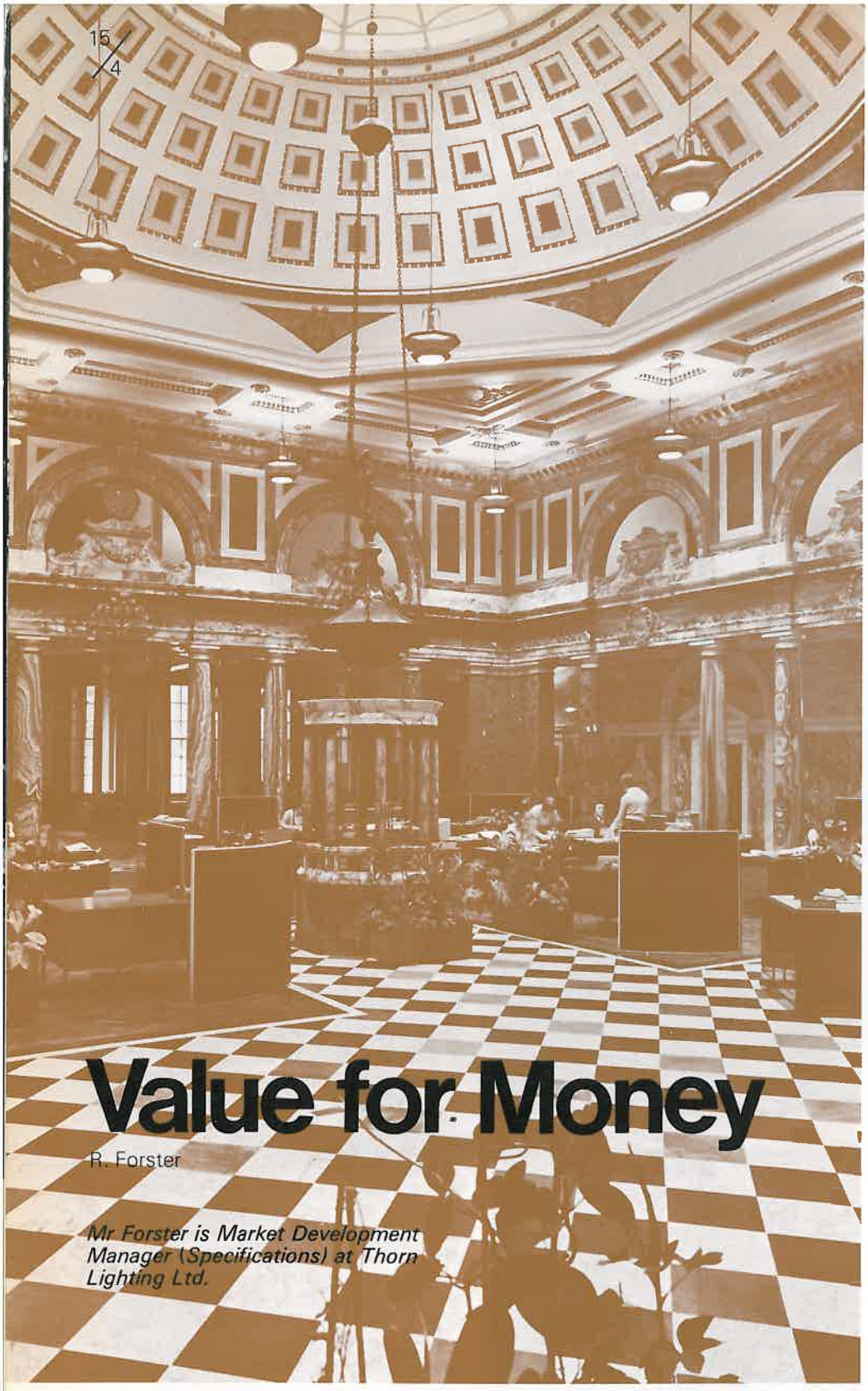
Lighting Considerations

The existing indirect lighting installation consisted of 1000 watt Tungsten Halogen floodlights supplemented by 750 watt MBFU lamps taking a total load of 15 kW and provided a horizontal illuminance of 80 Lux over the court. This was totally inadequate for a game which has much in common with modern lawn tennis and also has some similarities, as far as speed and visual task of the players is concerned, with squash and badminton. The current recommended illuminance for all three sports is 300-500 Lux and this was obviously a sensible design target for Real Tennis. This could most economically be achieved by using a direct lighting system with the luminaires above the windows at 9-10m but even if this mounting position had been acceptable to the Department of the Environment, which controls all matters relating to the fabric of Hampton Court — such an installation would have imposed access problems for maintenance. Apart from these considerations a direct lighting system would also present a visual comfort problem for the players which would be aggravated by the low reflectance of the floor, walls and window areas.

The Final Scheme

For these reasons an indirect system was recommended using 36 Sonline floodlights mounted on the windowsills at 6m and on the end galleries at 7m. The windowsills can be reached from an exterior catwalk which runs down both sides of the building. The floodlights, housing 400 watt SON/TD linear high pressure sodium lamps provide an average horizontal illuminance of 500 Lux with a total load of 16.35 kW; giving more than a five-fold increase in the system efficiency. The floodlights have been aimed so that bare lamp cut-off occurs just above players' eye level. This, apart from limiting direct glare, also ensures a high vertical illuminance over the opposite window area where the effective brightness of the windows with their white glazing bars form an effective transition between the high brightness of the ceiling and the black court area. To avoid any risk of stroboscopic effects, adjacent and opposite floodlights are connected to different phases of the supply.

The Members of the Royal Tennis Club at Hampton Court now claim (probably without fear of contradiction) that theirs is not only the oldest but the best lit Real Tennis Court in the world.



The entrance hall of the Head Office of Norwich Union, built at the beginning of the century by G. J. Skipper. The relighting of this magnificent marble hall is described on page 5 of this issue.

Value for Money

R. Forster

Mr Forster is Market Development Manager (Specifications) at Thorn Lighting Ltd.

The term 'value for money' is an attempt to express human needs and desires on a quantitative basis. It is difficult for most people to relate the accountant's balance sheets with income neatly set against expenses as a measure of human effort against achievement. This supports the saying that todays values are indeed changing and it is the combination of yesterday's experience and today's information that will set the standards for the future.

How can this be related to lighting? By remembering that lighting is provided for people, and that it is only part of an environment for human comfort and efficiency. The aims of good lighting are simple, optimum visual performance and comfort, but in cost terms a compromise is necessary to balance the accountants' books.

Value for money results from the combination of two basic requirements. Firstly the quantity and quality of light that gives the best return in terms of productivity and staff satisfaction and secondly the selection and application of the most effective light-source and luminaire to meet those requirements.

Consider the situation of an average office worker. He does not actually manufacture any useful commodity and his work is therefore entered in the ledger as "overheads". His main task is reading paperwork and over the past decade not only has the volume of paper increased but the legibility has decreased as the type and script becomes replaced by computer printouts, photocopies and telexes. But over the same period his salary has increased, his union has negotiated better holidays and a shorter working day. External noise and pollution have increased too, necessitating the provision of air conditioning, so that it may be difficult to ascertain whether improved performance and productivity has been obtained by better lighting or other environmental conditions and a demand for better lighting may be considered unreasonable.

Benefits from Good Lighting

Lighting manufacturers are constantly developing more efficient light sources and producing luminaires that control and distribute light to provide better visual conditions. Lighting researchers can measure improvements in visual performance under controlled laboratory conditions, but only the eventual user can determine the value for money that results from these efforts. Some activities have an end product that is difficult to express in monetary terms, for example those carried out in art galleries or schools. The value of better educated children in twenty years time may be difficult to predict in quantitative terms, but this should not be taken as an excuse for inaction.

In the commercial areas where there is a known end product however, there are many benefits in improved lighting that would enable the value for money to be more easily assessed. These may be listed as follows:

1) Productivity. How does the cost of better lighting compare with new plant or a larger work force?
2) Quality Control. What reduction in errors would be achieved by better lighting?
3) Safety. Accidents cause hardship and loss, would better lighting reduced accident rates?
4) Security. Would better lighting offer greater protection?
5) Absenteeism. Would better lighting reduce sick leave from eye strain?
6) Amenity. Would better lighting improve recruitment and satisfaction of staff?

Part of the Service Hangar of the Royal Air Force Establishment at Farnborough, where the use of Kolor SON lamps has effected a remarkable economy.

All too often these questions are left unanswered because insufficient data is available. The Illuminating Engineering Society makes general recommendations on lighting requirements and a qualified lighting engineer can advise on specific application problems, but in the final analysis the answers must be part of the responsibility of the individual company management.

However, a lighting manufacturer can demonstrate how his equipment can reduce direct costs, not by reducing lighting standards but by improving efficiency of performance of both lamp and luminaire. By studying comprehensive data on performance, consumption and life, it is possible to compare the total cost of different lighting options designed to achieve the same lighting specification.

The total cost of a lighting installation can be broken down into three main components.

1) Initial capital cost
2) Annual running cost
3) Annual maintenance cost.

Capital Cost

The initial capital cost includes the cost of luminaires, the cost of the initial set of lamps, and the cost of installation. Set against these costs is the saving that may occur from tax relief, government grants and the value of existing lighting equipment, if any.

The lowest capital cost scheme can often be the most expensive in the long run, so it is important to consider the other two sections before reaching a decision. In addition, costs need to be assessed in relation to the predicted life of the installation. Most lighting equipment is capable of a useful life in excess of the user requirement. There are many installations still functioning satisfactorily after 20 years, but conversely there are many buildings where the function, layout and equipment modification necessitate changes to the lighting system after 5-10 years.

Finally the cost of interest on any capital outlay may need to be related to the predicted life of the proposed installation.

Annual Running Costs

This is the cost of annual energy consumption and the average cost of replacement of lamps. Because energy costs are rising it is particularly important to ensure that the lighting load is not excessive as for most installations the cost of electrical consumption is the largest cost factor in their total life cycle.

Most interiors do not rely entirely on artificial lighting but benefit from natural lighting to some degree. In order to gain the full benefit from any daylight that exists, the switching system must have sufficient flexibility for convenient control by the occupants. All too frequently switching arrangements are inadequate and inappropriate. For only a small increase in the initial installation cost, very worthwhile reductions in energy consumption can be achieved.

Maintenance Costs

These include both the relamping and cleaning costs. A dirty lighting fitting costs just as much to run as a clean one but gives a reduced lighting performance. Lamps are usually more expensive when purchased in small quantities and where there is a predictable and regular usage of the lighting equipment it is worth considering a bulk replacement to coincide with a cleaning cycle. In this way the cost of labour can be expressed in only pence per lampway, which is much less than for unplanned maintenance.

An Example of Planned Maintenance

Associated British Foods has recently turned over to a group replacement system and anticipate an annual saving of £100,000. Replacing each lamp as it fails, as has been done in the past, may cost up to £5 a tube, and since in an average year 2,500 of their shops require the replacement of about 50,000 fluorescent tubes, this can amount to an expenditure of well over £200,000 per annum.

The new planned maintenance scheme is operated by contractors who replace all the tubes in a shop every two years at a cost of 27p per tube, effecting a very considerable cost saving, the tubes are being used for about 6000 hours of their rated life of 7500 hours, resulting in a higher average lighting performance.

Direct Costs

Although there will be many variations in costs due to the quantity and quality of lighting required and the type of installation, the figures given below for a typical factory area using fluorescent reflector type fittings, can be taken as a useful guide.

1) Capital Costs	
Cost of lighting fittings	£1080
Cost of installation	£1900
Cost of initial batch of lamps	£ 112
Total	£3092
2) Annual running costs	
Electrical Max. Demand Charges	£123
Electrical Unit Consumption	£546
Replacement lamps	£ 45
Total	£714
3) Annual maintenance cost	£98
Final Total	£812

If one assumes a life cycle of ten years for the lighting installation, the total running and maintenance costs, becomes £8,120 assuming price stability for energy and labour over this period. A modest increase in these would raise this total cost to about £12,000. Similarly allowing for

reasonable interest rates on the capital outlay the total capital cost would be approx £6,000.

Thus in the life cycle of the installation the capital cost expenditure is only half that of the total running costs.

The Pay-Back Period

This type of cost comparison can be used to compare different solutions meeting the same lighting standard, both for new installations and for buildings with existing lighting, for even if the existing lighting meets the requirements of visual performance it may not represent value for money in todays conditions. In this situation a simple method of evaluating the proposed and existing schemes is to consider the pay-back period. This is the time taken for the savings in annual costs to cover the initial capital expenditure, for although the proposed installation will involve initial capital expenditure it should offer reduced annual costs.

If the same factory had previously used filament lighting to provide the same illuminance the following comparison can be made with a fluorescent lighting scheme.

Existing lighting total annual costs	£3541
Proposed lighting total annual costs (including maintenance)	£ 812
Savings per annum from proposed installation	£2729
Capital expenditure for proposed installation	£3092
Pay back period $\frac{3092}{2792}$	13/14 months

In todays climate of careful cash flow control and high interest rates on borrowing a proposed lighting scheme that offers no other benefits than economy of running should have a pay-back of not more than 1 or 2 years.

The installations described below give actual examples of the savings that can be effected.

The Norwich Union

The entrance hall of the Head Office of the Norwich Union, illustrated on page 4 of this issue of *Lighting Journal* was originally lighted by 1000W incandescent lamps in decorative pendants. Substituting 400W Kolorarc (MBIF) lamps in the sixteen luminaires, halved the total load and raised the illumination by about a third. Control gear was remotely mounted. The original annual consumption was in the order of 48000 kWh.

An electrician fits one of the new Beta 5 lanterns on an existing column in Manchester. No extra equipment is necessary as control-gear is housed in the lantern.

A Warehouse in Abingdon

Bishops Stores Ltd had used twin 8ft 125 watt metal reflector Popular Pack fittings for the lighting of their warehouses. When the lighting of their Abingdon warehouse was being planned they compared this with the new Clipper fittings using 6ft 75 watt lamps. The combination of the better performance of the Clipper fitting and the higher efficacy of the 6ft 75 watt lamp enabled the following reductions in electrical load to be achieved without reducing the lighting levels.

43.7 kW reduced to 36.5 kW
69.2 kVA reduced to 37.3 kVA

In monetary terms the Clipper solution effected a reduction in annual electricity bills of about 20%.

Replacing the tubes alone can effect a saving

The Carrefour hypermarket at Eastleigh used Warm White fluorescent tubes. The colour rendering of merchandise on the sales floor could have been improved by using Natural lamps, but these, in common with other fluorescent lamps of improved colour properties, have a reduced light output, so to maintain the existing illuminance, the number of lamps used would have had to be increased by approximately 30%, with the corresponding increase in electrical consumption.

The Plus White tube is a new lamp which combines high efficiency with good colour rendering. The existing warm white tubes have been replaced by 800 of these lamps, achieving the desired result of improved colour appearance throughout the store with no increase in the consumption of electricity.

H.I.D. lamps in an Aircraft Hangar

High pressure mercury discharge high-bay lighting had been used in the service hangar of Southern Squadron at the Royal Aircraft Establishment Farnborough which was now due for improvement. A new scheme was prepared based upon 700 watt Kolorlux (MBF) lamps with a total lighting load of 67 kW.

High pressure sodium lamps were then considered as an alternative. The higher light-output of this lamp would enable the same scheme to be adopted but with a 400W. KolorSON in place of each 700 watt Mercury lamp. Fortunately, the high pressure sodium lamp had been used already on the same site in a wind tunnel and it was therefore possible to assess whether its warm colour would be suitable for servicing requirements. Typical components were examined in the wind tunnel and the visual conditions under high pressure sodium lighting proved satisfactory.

It was therefore possible to re-light the hangar with KolorSON lamps, resulting in a total lighting load of only 42kW instead of the 67 kW originally envisaged.

High Pressure Mercury Lamps in a factory

The Weeway Watson factory in Glasgow had a lighting system that used 78-500 watt tungsten lamps. These were replaced by only 39-400 watt high pressure mercury lamps. The lighting level was doubled and the electrical consumption halved. The long life of the mercury lamp also greatly extends the period between lamp changes thereby producing savings in maintenance costs.

Street lighting can also show economies

Technical advances in the design of lamps and luminaires are not only valuable in industry and commerce. The use of the new 35W SOX (low pressure sodium) lamp fed by the new Thorn low-loss choke and ignitor circuit in Beta 5 lanterns mounted on the original columns has virtually revolutionised the lighting of side streets in Manchester. Some 400 miles of roadway, previously lighted by 150W filament lamps, are now bright with sodium lighting.

The scheme gives twice the light with a 60% reduction in running costs and the lamp replacements, previously obligatory every three months now take place at 18 months intervals, very substantially reducing maintenance costs.

New Facilities for Lighting Research

A H Willoughby

Mr Willoughby is Director of Research and Engineering, Thorn Lighting Ltd.

Using a goniometer to measure lighting intensities from a floodlight. The beam is directed into the tunnel behind the operator and the intensity measured by a photo-electric cell, 40 m from the light source and recorded automatically.

Thorn Lighting is almost unique among the large lamp manufacturers of the world in that its lamp business is coupled with an equally large lighting fitting business. This combination leads to considerable benefits in the Research and Development area in that the development of light sources can proceed hand in hand with the development of associated lighting fittings. The design features of one can be adjusted to accommodate those of the other on a more or less continuous basis during the whole of the development phase.

The Company's research and development facilities are almost equally spread between two of its largest industrial sites, one at Enfield, the other at Leicester. This split siting allows a close contact between many of the R & D personnel and the factories which they are serving.

At the Leicester laboratory the work covers the development of sources which are made in our large factory at Leicester and at factories at Preston and Merthyr Tydfil. Also at Leicester is the lamp research unit which is looking for entirely new types of light sources. The Leicester laboratories are modern and well suited to the Company's needs.

At Enfield, the R & D work covers those light sources which are made in factories in the London area and in addition, all activities relating to the lighting fittings business and the associated electrical and electronics circuitry.

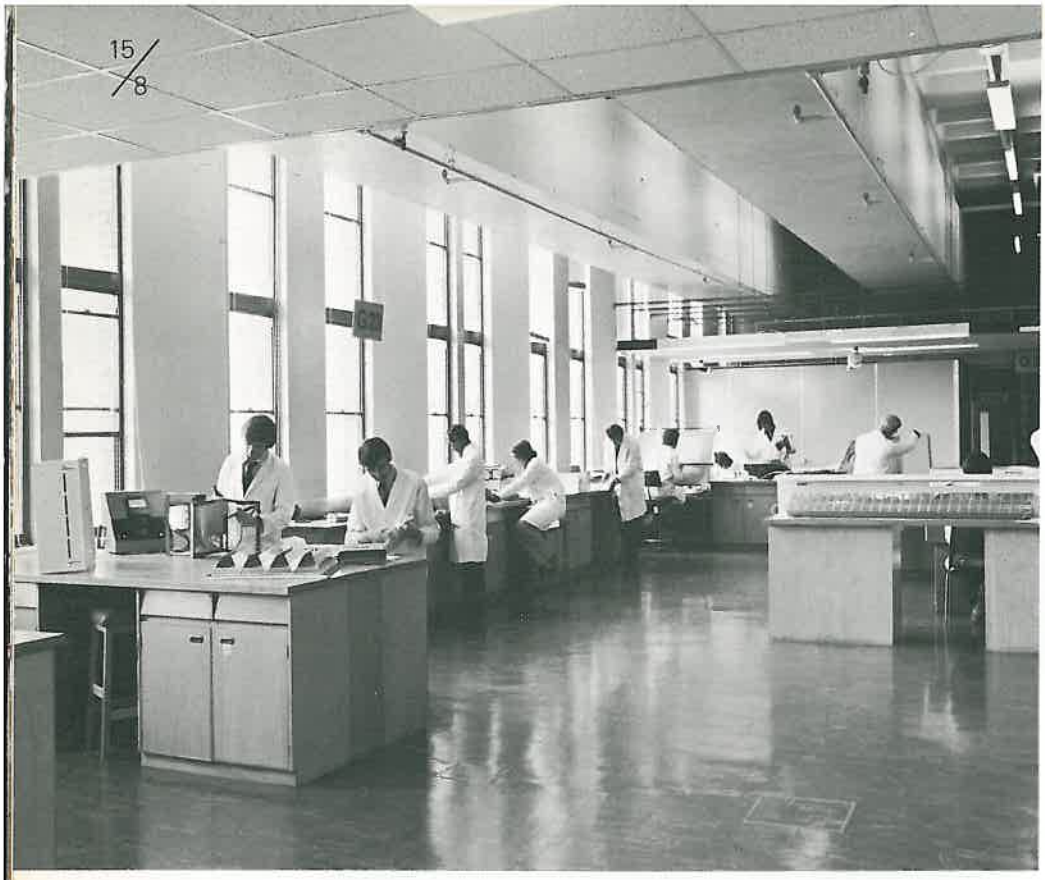
Until recently facilities for this work were housed in the old Atlas Laboratory building or were inconveniently scattered around the factory complex. In particular, the facilities for the development of lighting fittings and for lighting applications research were totally inadequate.

It was to overcome these problems that the company decided, some three years ago, to build on the Enfield site the new multi-storey, purpose built laboratory building which was described by the architect Mr Gale-Brown, in the last issue.

The building was opened on the 12th September 1975 by the Prime Minister and is now fully operational. In this article is described some of the areas of work which are being carried out within its walls.

Requirements for Lighting Fittings

In recent years the company's range of lighting fittings has become very wide, extending from the well known fluorescent Popular Pack to highly specialied equipment such as the narrow beam floodlights used for football stadia lighting and special airfield runway fittings.



A general view of the photometric laboratory. The two goniometer tunnels can be seen suspended from the ceiling.

All have to conform to tight optical and thermal specifications and in addition must comply with safety and performance standards which are mandatory in the large number of overseas countries in which they are sold.

The Lighting Fittings Development Laboratory

This is perhaps the most impressive part of the new building. Its ceiling, which is 5.5 metres high, is of reinforced concrete "waffle" construction and at each waffle corner, set into the concrete is a suspension point which can safely take a load of several hundred-weight.

One important aspect of its work concerns optical performance and it has some spectacular facilities associated with this activity.

Suspended from the ceiling are two goniometer tunnels each having a 1.2 metres square cross section and a length of 43 metres. They are among the longest in Europe and allow very accurate photometric measurements to be made on narrow beam floodlights and spotlights. A goniometer is essentially a calibrated rotating head on which is mounted the floodlight or spotlight under test and it allows accurately defined rotations both in the vertical and horizontal planes. The light from the fitting is beamed down the tunnel which has at its far end a photo-electric cell to measure light intensity.

The Polar Curve Photometer is housed at one end of the laboratory where the ceiling height rises to 10 metres and is sufficiently large to allow accurate measurements to be made on lighting fittings up to 2.4 metres in length. A light plastic mirror mounted on an arm having a length of 4 metres, is rotated around the fitting from the vertically up to the vertically down position, the mirror directing to a photo cell the light which it collects from the fitting.

The mirror having completed its travel the fitting is rotated horizontally by a few degrees and the process is repeated. In this way data can be obtained covering the full light distribution.

All the light measurements made by this equipment are recorded automatically and fed to a computer which uses the collected data to calculate the installation design parameters required by lighting design engineers.

Testing Air Handling Equipment

Another important aspect of the laboratory's work relates to the design of air handling lighting fittings and of integrated ceilings and to assist in this work there are a number of special installed facilities. An insulated room has been constructed for the assessment of acoustic properties of both lighting fittings and ceilings. It is a massive double skinned structure, each skin being made of high density building blocks having a thickness of 200 mm. The outer skin is built on to the structural floor of the laboratory and the inner room is built on to a thick concrete raft which is separated from the structural floor of the building by 50 rubber mounting blocks. This facility, which is believed to be unique within the lighting industry, is fully equipped with the latest noise generating and acoustic measuring equipment.

In a room off the main laboratory is a highly flexible air-conditioning plant which serves the chamber and other test rigs in the main experimental area.

Lighting Applications Research

In addition to the development of lighting fittings there is, on the first floor of the new building, a large laboratory devoted to research into new ways of using light. Here are facilities for colour research and for programmes such as research on the relationships between street lighting and accidents, for which the Company has a Government Research Contract; for the development of computer programmes relating to the lighting of sports stadia for T.V. purposes and for research into all aspects of subjective comfort in artificially lit interiors.

The Test House

An important part of the laboratories is the comprehensively equipped test house on the third floor. It is run independently of the other departments and is recognised by the British Standards Institution and other European National Test Houses. Lighting equipment must satisfy the most onerous requirements both of the United Kingdom and European countries to which it is exported, so that a master standard has to be set up which embraces all of them. The work includes such things as electrical testing of individual components and complete luminaires, thermal tests to discover whether products run too hot in normal and abnormal conditions, testing at low temperatures, and an elaborate rain test. This takes place in a specially waterproof room where outdoor luminaires, such as floodlights or street lighting lanterns are mounted on a rotating head, lighted, and sprayed with water from an oscillating semi-circular water-pipe. Their resistance to thermal shock is tested and any tendency to suck in moisture noted.

Plastic materials are tested for flammability and resistance to mechanical and thermal shock, for electrical insulation, and for their tendency to 'track' — that is for the surface insulation between electrical conductors to break down. One test involves the use of mechanical fingers that probe into the unit to find if any 'live' parts can be touched accidently.

Luminaires are run for long periods at 10% overload to establish their thermal durability or, in the case of streetlighting lanterns, vibrated in a special machine to test their behaviour under windy conditions. In the adjoining, but separately run Material Research Department, new materials are subjected to searching tests to determine their suitability for use in Thorn luminaires.

Right: A technician works on a complicated electronic circuit, the prototype of an emergency lighting controller, mounted on an open board.

Bottom right: Fluorescent tubes are fed automatically into this integrating sphere to measure their light output.

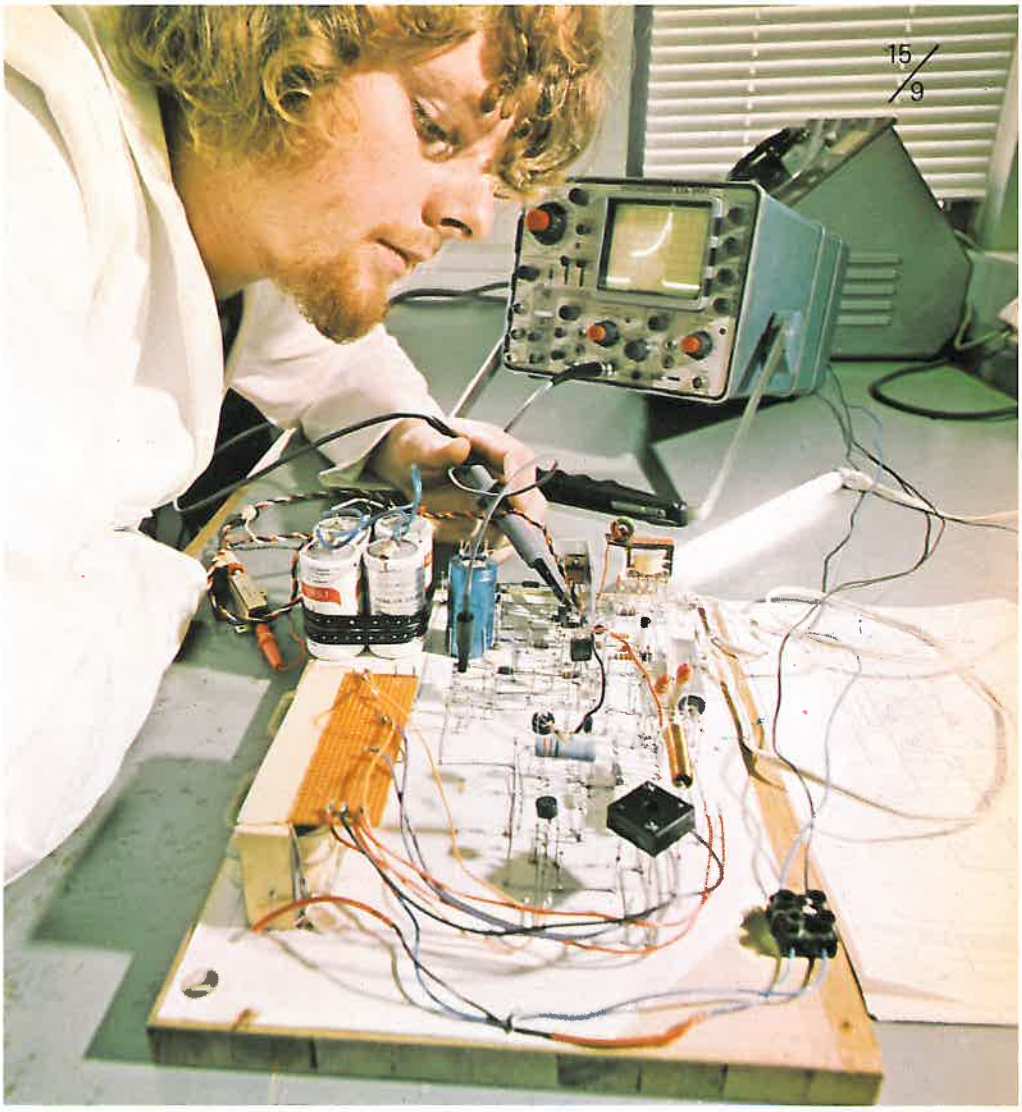
***Bottom left:** The speed and distribution of air movements in a suspended ceiling can be observed and recorded by puffing smoke through it and registering the results on this apparatus.*

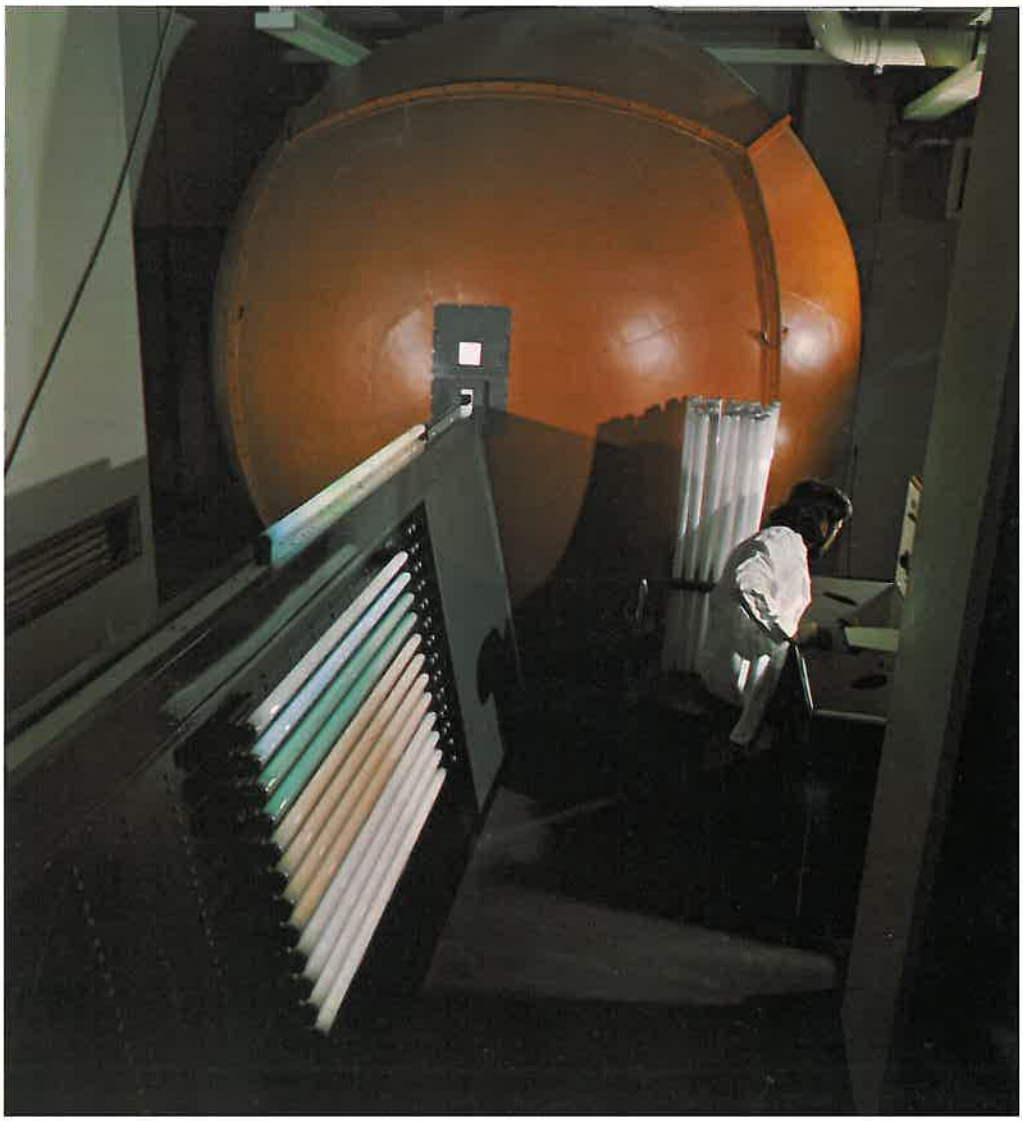
Electronic Research

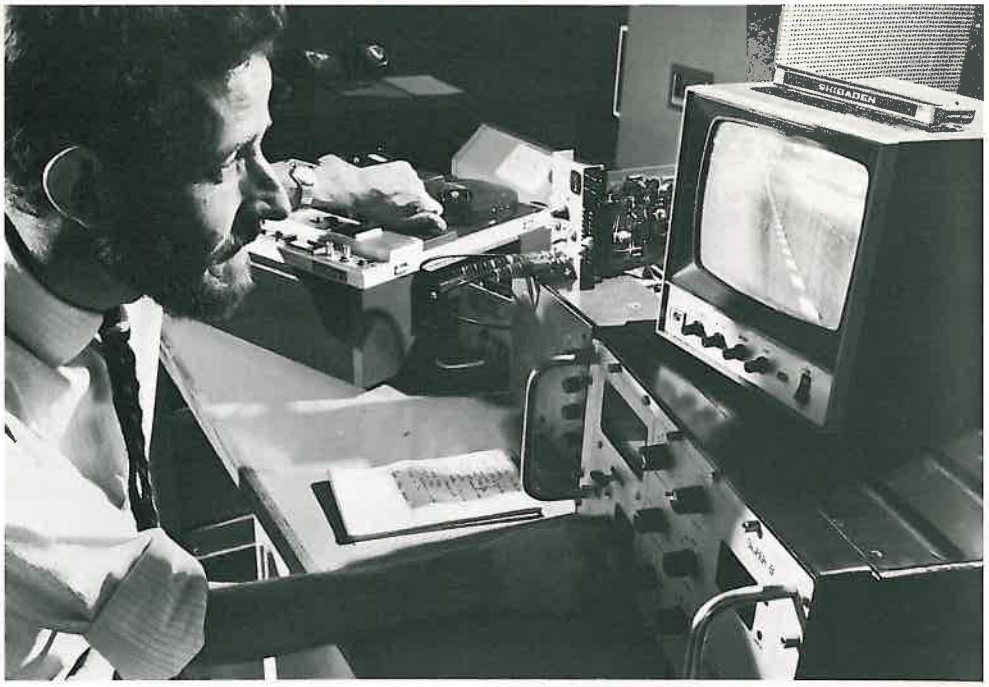
Electrical ballasts for various types of discharge lamps have developed a long way from the heavy and cumbersome units used to control lamp current in the early years immediately after the war. The size of ballasts is constantly being reduced and more efficient designs capable of high speed mass production have been developed. Today's ballasts are slim and quiet and are reliable whether run under high temperature or high humidity conditions.

Thorn operates one of the largest ballast factories in the world and are the biggest producers of fluorescent fittings in Europe, so it is appropriate that the fourth floor of the new Labs should be given up to research into control gear.

A new and rapidly expanding field is that of transistorised ballast equipment used in transport lighting and for self-contained emergency lighting units. In the field of electronics too, is the development of computer memory systems used in theatre and studio lighting all over the world. Thorn's first "Q File" system was installed by the BBC in 1967 and today the Company sells equipment of this type to television studios and theatres all over the world. More recently the laboratory has developed low cost automatic dimming systems for clubs,







Right: Video-tapes made in actual road conditions are played back and brightness contrasts measured and evaluated as part of the Road Research project.

Below right: Very fine films are deposited on a plastic base to make image retaining panels.

Bottom right: Looking downwards at a polar-curve photometer. The luminaire is mounted on a rotatable head and its light reflected from the mirror which effectively doubles the length of its path to the photocell. Once the luminaire has been installed the process is automatic, the operators do not remain in the chamber.

schools, discotheques and the amateur stage.

The electronics group also developes electronic control equipment to control highly complicated lamp making machinery installed in the Company's own factories.

Fluorescent Tube Development

The manufacture of fluorescent tubes was the beginning of Thorn's success and the development of new types is still a very important part of the Company's present activities. The fifth floor now houses the laboratory in which such recent innovations as the Plus White tube and the new krypton filled 100W tube were developed. This latter tube replaces a standard 125W tube in starter-switch circuits to give substantial energy savings with minimal loss of light.

The new fluorescent tube laboratory is well equipped and includes a mass spectrometer which can sample the gas in a tube while it is in operation, special refrigeration equipment for the investigation of tube operation at low temperatures and a 3.5 metre diameter spherical integrating photometer which has a jolt-free linear motor to insert and withdraw fluorescent tubes.

A life-test room and an associated test laboratory enable the evaluation of all new tubes on our own and our competitor's ballasts. Attention at the moment is focussed on the performance of tubes running on battery operated high frequency circuits such as are used in transport and emergency lighting.

Tungsten Halogen Lamps

The work of the Tungsten Halogen Lamp Laboratory over the past ten years has given the company a world wide leadership in this important and comparatively new range of light sources and its achievements were recognised by the award of a Queens Award to Industry in 1972.

The laboratory has been responsible for the development of a wide range of new lamps for photographic, floodlighting and transport applications and its extended facilities, following the completion of the new building, will enable it to continue to maintain the company in the forefront of this important field.

Phosphor Research

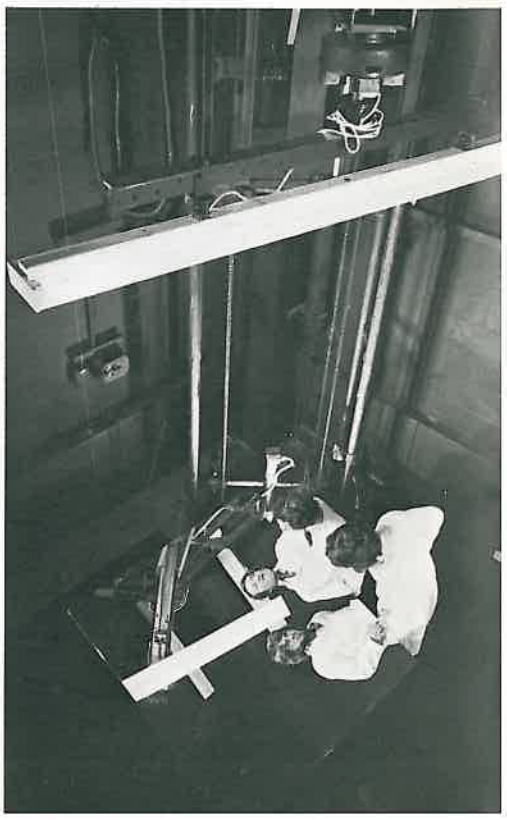
Most people know that a phosphor is a substance which converts ultra-violet to visible light and that the light emitted by a fluorescent tube emanates from such a substance. Today, about 60% of all artificial light generated in the world comes from the fluorescent tube, so it could be said that phosphors are the most important of all light sources.

In addition to the fluorescent tube application, phosphors also have important uses in high intensity discharge lamps and it is perhaps in this area that their use will be extended in the years to come.

The Company believes that phosphors will continue to have an important place in light source development for many years to come and has consequently expanded its research facilities in this field, following the completion of the new building.

Conclusion

In the reception area of the new laboratory, enshrined in a glass case, is one of Sir Joseph Swan's first carbon filament lamps. It was made in about 1880 and it serves as a remainder that the electrical lamp industry is now almost 100 years old. During that hundred years, the pace of research and development within the industry has steadily and consistently accelerated and there is little doubt that this trend will continue into the future. The Company believes that the new facilities recently opened at Enfield, coupled with the modern laboratories which it has already at Leicester, will enable it to continue to play a leading international role in the advancement of the science of lighting.



Mechanical Services at Enfield

H. A. Miller

The main entrance to the laboratories. The drum concealing the staircase can be clearly seen as well as the brick shafts which carry service ducting from the second to the fifth floor.

Mr Miller is Deputy Managing Director of Thorn Benham Ltd.

The mechanical services of the new Thorn Laboratories are of considerable interest, as they had to allow for future requirements which might be much in excess of those at the present time. There were some special features resulting from the design of the building; for example, it was necessary to provide underfloor heating in the entrance drum to overcome the chill from the concrete floor of the car park. While the Main Reception area is fully air conditioned to maintain internal temperatures and relative humidity, the full height glass windows on the west side are provided with a pedestal mounted convector heating rail, which also serves as a protective barrier.

The Lecture Theatre has an independent air conditioning system as it is likely that there will be occasions when it will be in use outside normal working hours. The environmental conditions give an almost immediate response to temperature and humidity should a large number of people occupy the Theatre. It is possible to supply 100% fresh air by remote switching of the by-pass dampers. A separate air handling plant is provided in the office area.

Special equipment necessary for environmental testing

On the second floor is the environmental test and appraisal area where modular testing is carried out. Here actual project conditions are simulated and an installation is provided capable of maintaining any set temperature within the range of 20 °C and 35 °C under a test load of 2 kW with a relative humidity band of between 30% and 70%, with a sound level not exceeding NC25/30.

The system incorporates an air handling plant in a special plant room with its own chilled water generator on this floor. The air may be supplied to the required area the remainder being re-circulated through a by-pass duct to the main supply plant and its volume varied by automatic control dampers from a central control panel. Thus one area at a time can be conditioned, the non-working area being isolated by blast gate dampers.

Conventional heating on other floors

Other floors of the laboratory have conventional perimeter continuous convector heating served from a single steam/water calorifier, compensating the water temperature to the outside air temperature. Equipment can be plugged into trunking and the fumes from the equipment extracted to the roof area and discharged to outside air.

Supply other than electrical services

A carcass system of service pipes has been installed on all floors providing natural gas, nitrogen, hydrogen and oxygen for industrial use together with drinking water and other water systems. Extensions can be taken at any time in the future to individual pieces of new equipment. All pipework services run in a main duct 7.6 metres wide, running the full height of the building at the south end. Similar ducts are provided at the north end and in the centre of the building.

The main plant rooms

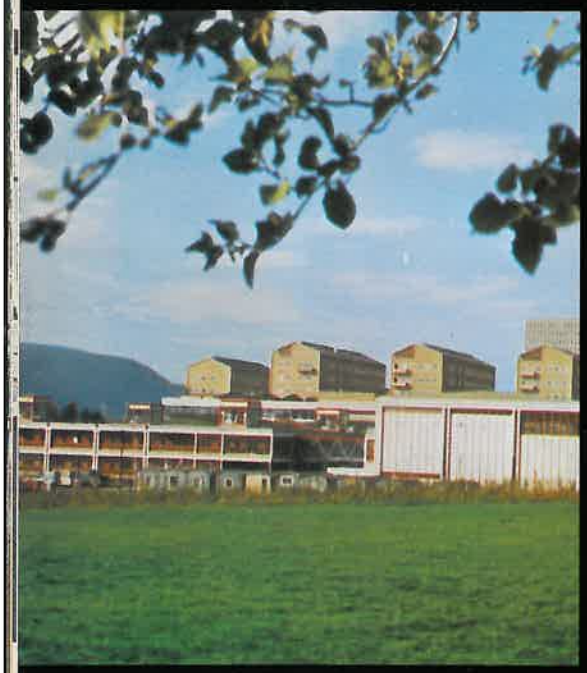
The main plant room on the roof is divided into two for convenience.

In the south end of the plantroom is located all the calorifier equipment. Water pressurisation equipment and a condensate receiver are located in this area, and a gantry has been built to carry the pumps for the cooling water, the fibreglass de-mineralised water tank and the 'Scanflex' heating and chilled water pressurisation units. Beneath the gantry are the main cold water storage tanks and the heating calorifier and its pumps.

The other plantroom area contains the air handling plants, serving the First Floor general areas and the Lecture Theatre. The third plant which supplies conditioned and treated air to the Coating Room located on the Fifth Floor is a 100% fresh air supply system. At the extreme end of the room are the two extract fans for the Life Test area. Air is introduced through louvres with renewable filter frames and enclosures. With both fans running the air extraction rate is inside two minutes. The heat load from the area built up from fluorescent tubes under test conditions is calculated as 360 kW per hour.

A refrigeration machine and associated pumping equipment is located in the Dry section of the roof-top plant room and serves the air handling units as well as providing a piped circulation of chilled water to all the floors.

From Pole to Pole



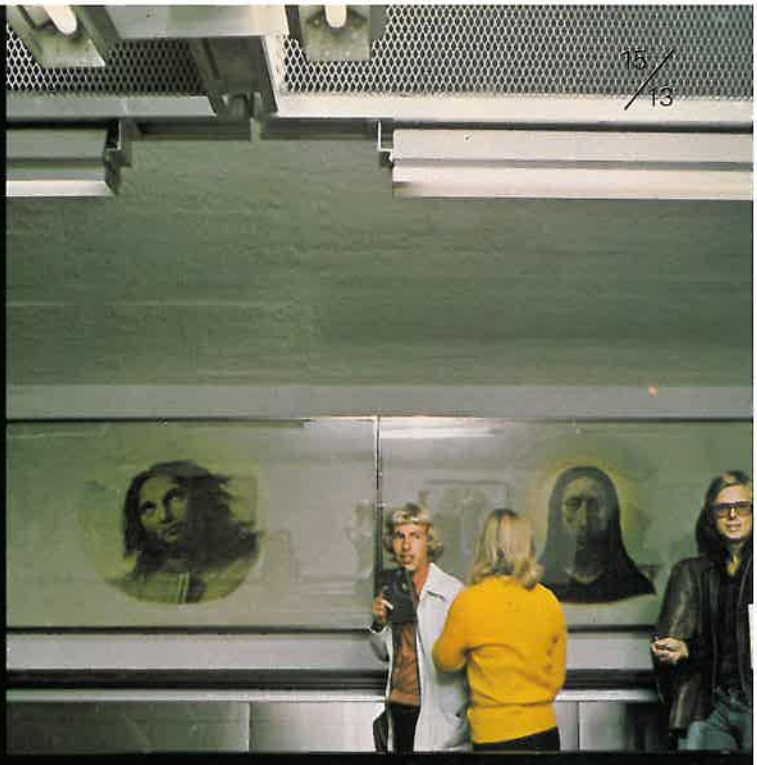
Above is a view of the new University at Trondheim lighted by Thorn's Norwegian subsidiary. On the right from top to bottom are the Medical Library and a laboratory at Otago University and the Dunedin Hospital Lecture Theatre, all in New Zealand.

From Pole to Pole

With the possible exception of Reykjavik, Trondheim University in Norway is the most northerly in the world while there is no doubt that Otago University at Dunedin in New Zealand is the most southerly. Thorn has lighted both of them and has branches in both cities. The installation at Trondheim is not yet completed and is of special interest because the main hall, 12-14 m high, is to be lighted by MBIF lamps — the first installation in Norway. We hope to publish details of this installation in our next issue.

The two chemistry blocks and the University Medical Library at Otago and the Dunedin Hospital Lecture Theatre were lighted from the Dunedin office, Thorn's most southerly branch. The lighting fittings in the lecture theatre house 700 4' 0'' 40W Deluxe White tubes. The lighting is controlled by a six-stage variable switching system, giving a variation of from 5% to maximum illuminance: 800 lux is provided over the rostrum from fluorescent tubes mounted above anodised aluminium louvers

The average illuminance in the Chemical Block of the University is 300 lux: the 4' 0'' surface mounted fittings being mounted in pairs for aesthetic reasons. 5' 0'' 65W Coolwhite tubes were used. In the Medical Library Thorn recessed luminaires, each housing four 4' 0'' 40W tubes give an illuminance of 300 lux. All lighting equipment was manufactured in Thorn's New Zealand factories.



Lighting Stockholm's Underground

Bjorn Dreyfert

Mr Dreyfert is the advertising manager of Thorn Belysning AB, Sweden.

Artists have painted the walls of the stations in Stockholm Underground transforming it into a veritable art gallery. Thorn Belysning designed and made the special lighting equipment needed for this job and delivered it on site to a very tight schedule.

Top: Loading the luminaires on to the trailer at the factory. An average of 600 per week were transported to site.

Below: The equipment is transferred from the trailer on to railway trucks.

Bottom: They finally reach their destination in the tunnel.

Dramatic things are happening under the ground in Stockholm today, for the worlds largest art-gallery, the only one in which the observer is literally carried from one work of art to another was opened this Autumn.

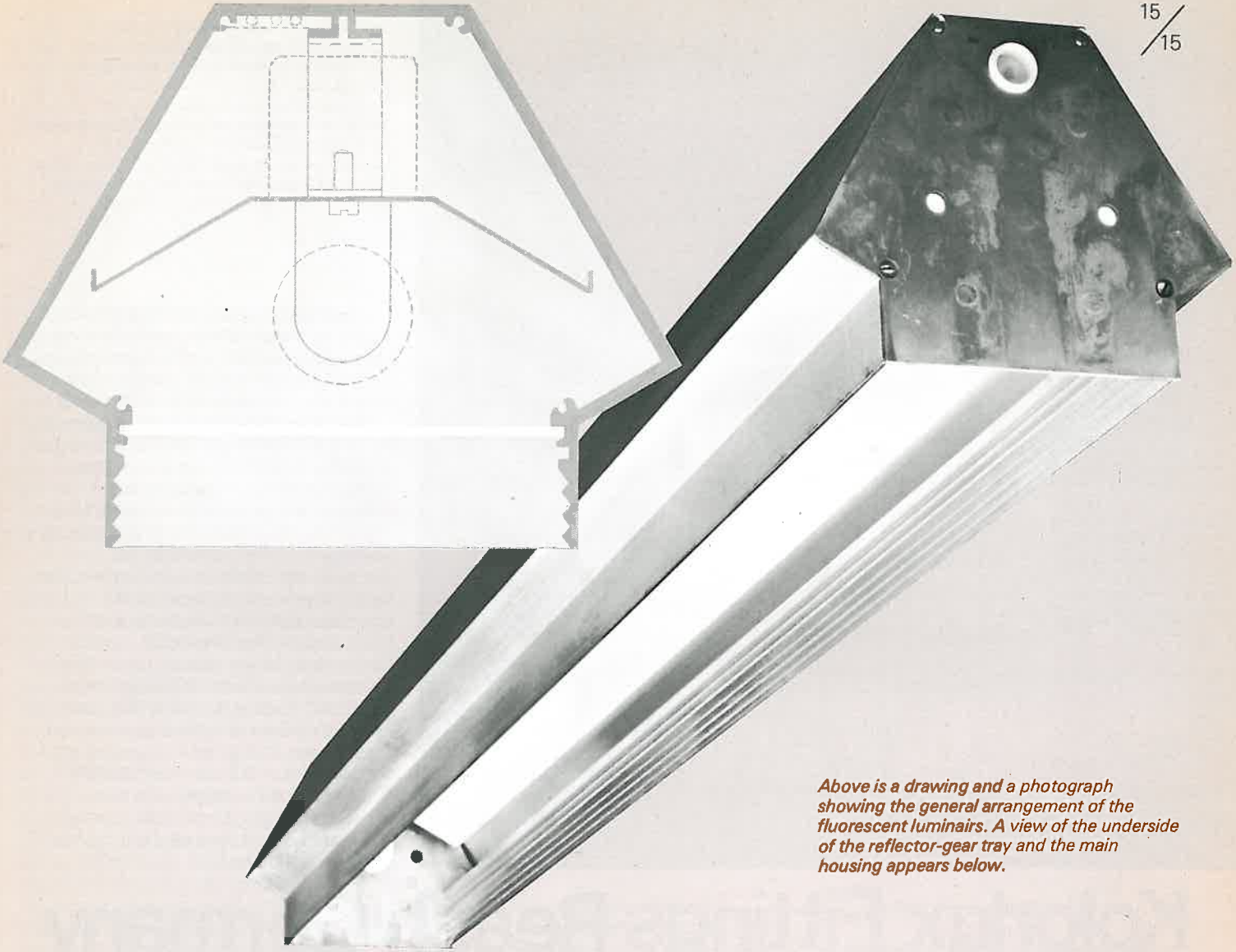
Stockholm claims that its underground railway is the most modern in the world. Now travelling on it is a unique experience, for the municipal authorities have decreed that each of the eleven new stations on a recent extension should be decorated by a different artist. Since much of the subway is hewn out of solid rock, this gives an enormous amount of freedom of expression to the artists and to travel along the subway is an aesthetic experience and will undoubtedly become a tourist attraction.

But pictures are no use unless they can be seen, so Thorn Belysning AB were given the task of illuminating the new stations. They had to design, construct and deliver 16,000 special lighting fittings divided between the eleven stations in no more than one year. The task was successfully achieved, partly as a result of very thorough planning by the Company and close co-operation both with the Architects Department of the Stockholm Local Communicators Company (SL) and with the contractors on the job.

A timetable was worked out as follows:

Month 1.	Define the lighting and physical properties of the equipment.
Month 2.	Decide on construction materials and techniques.
Month 3.	Arrange production schedules with the Swedish factory and place orders for components.
Month 4.	Testing and approval of prototypes by Semko (the Swedish test authority).
Month 5.	Commence production to give a delivery rate of 600 units per week.
Months 6-12.	Deliver on site and install lighting equipment.

The chief qualities required of the fittings were resistance to humidity and mechanical damage and versatility in use — the fittings should be suitable



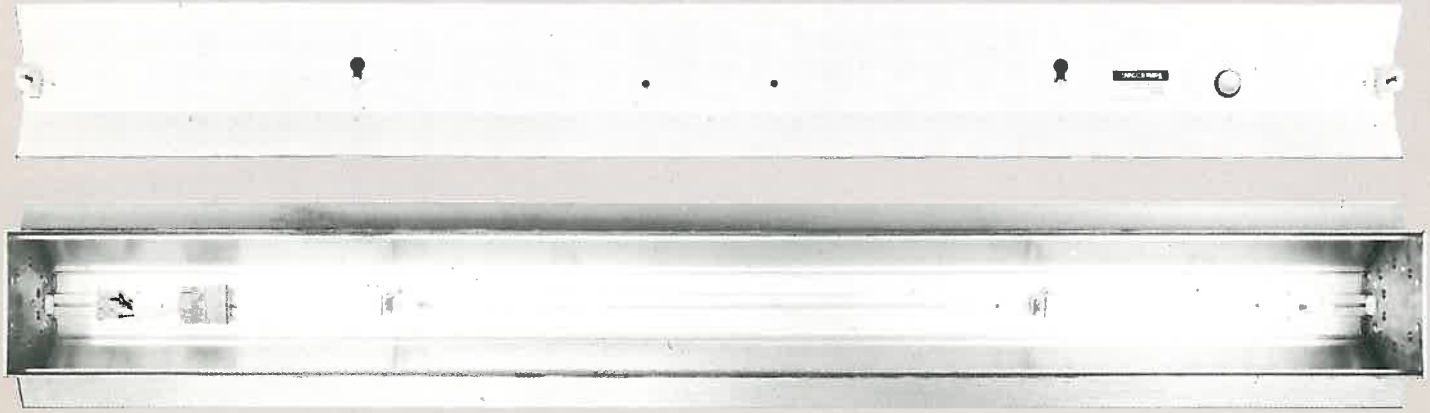
Above is a drawing and a photograph showing the general arrangement of the fluorescent luminairs. A view of the underside of the reflector-gear tray and the main housing appears below.

both for general lighting and for localised lighting of the decorated surfaces, posters, ticket booths, escalators etc. They should be easy to mount and both drip-proof and proof against mechanical and thermal shock and against vibration. They were to give the minimum glare with maximum light output.

Materials

In the course of the second month it was decided that the fittings would best be made of extruded aluminium. It would be possible to produce an extruded profile which incorporated baffles to prevent glare and ledges to support a plastic diffuser which would also serve as a lamp guard. Embedded axial threads could be included in the extrusion and these are used for mounting components, terminal blocks and end-caps. Each cap has eight knock-outs which can be combined in pairs to obtain seven different angles for mounting the extruded suspension stirrups which are used for all fittings. The suspension rods are standardised and are also used for loudspeakers, information boards etc. Lock-head bolts secure the screw clamps to prevent them unscrewing due to vibration. The anti-corrosive treated steel gear trays are fixed into the spines by a key-hole attachment with a 3-pole plug and socket connection for easy replacement. Glare is avoided by the 45° cut-off of the main spine and by longitudinal baffles and the fittings conform with the SEMKO S.22 grade.

Delivery was prompt to time at the first station and continued throughout the contract. During the seven months delivery period an average of 600 fittings per week (a full load for a long distance lorry trailer) has been maintained. In all about 25 loads have been sent, to a value of about 2,000,000 Kroner and a total weight of some 160,000 kilos.



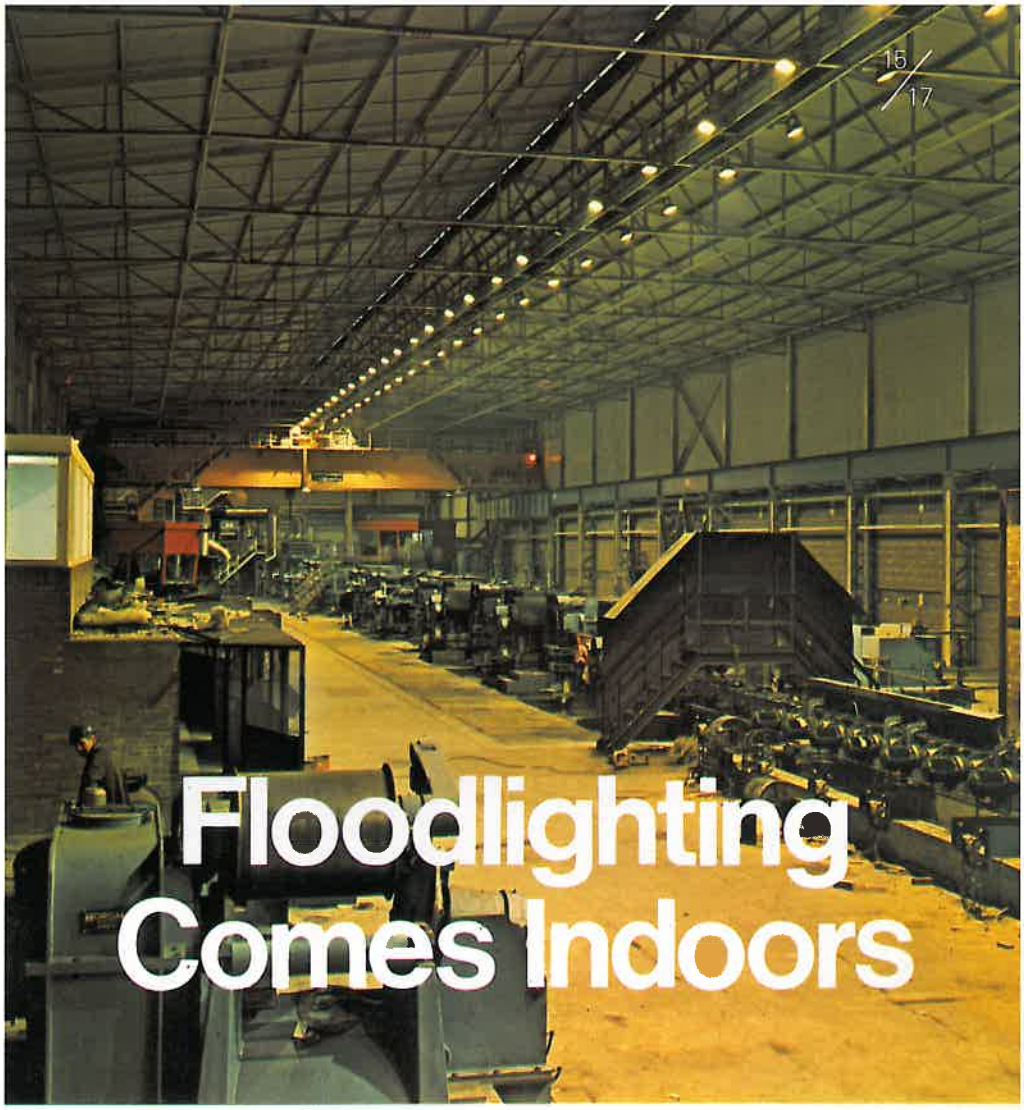
Left: A general view of the Volksbank at Lahnstein. Thorn Kolorlux Packs were specially imported to provide the general lighting.

Below: A view from the gallery. The cylinders masking the suspension cables of the luminaires can be clearly seen. A Thorn Haline floodlight is mounted near the clock to light an exhibition area on the ground floor.

Lahnstein is a small walled city near Koblenz. It is situated where the river Lahn joins the Rhine, and has a new Town Hall just outside the city wall which also incorporates a Volksbank.

The main hall of this bank is lighted by Thorn 125W Kolorlux Pack fittings, specially imported from the United Kingdom. They are suspended between the two-coloured concrete ribs of the main ceiling and provide an average illuminance of 400 lux. Because the cables on which they are suspended were architecturally unacceptable, they were masked by black metal cylinders which can be clearly seen in the picture taken from the mezzanine floor. Because of the restricted head room the office area below this floor is lighted by recessed fluorescent fittings giving an average illuminance of 700 lux. Two 1000W Thorn Haline floodlights are also provided to light an exhibition area in the main hall and one of these can be seen near the clock.

Kolorlux Fittings Reach Germany



A general view of the British Steel Corporation's new mill at Thrybergh, showing the lighting. Below is a closer view of the Haline floodlights mounted on the central catwalk. The two angles of inclination can be clearly seen.

Floodlighting Comes Indoors

D. J. Bridger, R. A. Kenery and K. Willis

Mr Bridgers is Section Leader of the outdoor lighting section of Lighting Research and Development at Enfield. His colleague Mr Kenery has now gone to Australia as manager of the research department of Thorn Lighting Industries Pty Ltd, and Mr Willis is Senior Project Engineer, Thorn Lighting N.E. Region.

The city of Sheffield has long been associated with the production of steel. For at least four centuries knife blades have been made in Sheffield and today it has retained its importance through the craftmanship bred through generations of skill. It is not surprising therefore that Sheffield is a centre of many of the British Steel Corporation activities particularly in the production of special steels.

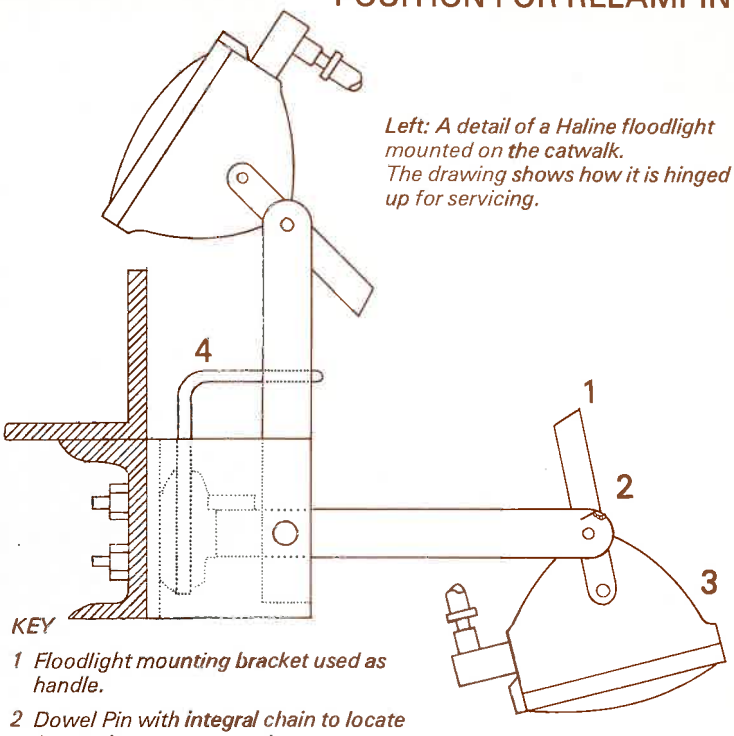
In the early part of 1973 plans were being prepared for the erection of a new bar mill on land at Thrybergh near Rotherham, Yorks for British Steel Corporation, Special Steel Division. The mill was to have a production capacity of 400,000 tons per annum of steel bars of various shapes i.e. flat, round, hexagonal and square up to 18 metres in length. The building is a low profile gabled construction consisting of eight individual bays, each some 20 metres from floor to ridge and about 30m wide, the main mill bay being some 428 m long. During the early stages of electrical design Thorn Lighting Ltd. along with other manufacturers were asked to put forward ideas for lighting this large industrial production unit. Thorn engineers suggested the use of the Haline floodlight incorporating a 400W SON TD linear lamp instead of a conventional high bay lighting system.

The Concept

The lighting installation was required to guarantee good visual performance, be easily maintained and be as economic as possible. Illuminance on both the horizontal and vertical planes had to be provided with reasonable uniformity but without excessive glare or severe shadowing, requirements similar to those of most area lighting systems. The impression of the amount of light in a space is derived more from the illuminance on vertical planes than on horizontal but adequate illuminance on all surfaces in the field of view is important for both visual and psychological comfort. A conventional high-bay lighting system lacks the horizontal component which may mean that vertical surfaces are not very well illuminated. The resultant "tunnel effect" is accentuated in a steel mill environment where surface reflectance is generally low.

Experience in lighting stadia for colour T.V. requirements such as Wembley and Arsenal has shown that a side mounted floodlighting system gives a good ratio between horizontal and vertical illuminance. However we have very little experience on how comfortable conditions can be achieved using low mounted side floodlighting in an interior. Only the Munich Olympic Sports Hall had a

POSITION FOR RELAMPING



Left: A detail of a Haline floodlight mounted on the catwalk. The drawing shows how it is hinged up for servicing.

KEY

1 Floodlight mounting bracket used as handle.

2 Dowel Pin with integral chain to locate floodlight at correct angle.

3 Normal mounting position of Haline Floodlight.

4 Hook to hold floodlight in position during relamping.

similar system (Light and Lighting November 1972) but the arrangement, circumstances and requirements were quite different.

In a continuous production high-output mill of this kind the planning of access to the lighting for maintenance is of prime importance, for production cannot be interrupted. Access must be built into the structure of the building and in most steel mills the conventional high-bay installation takes the form of an extensive grid of catwalks throughout the length and breadth of the building. The alternative is a lighting system consisting of a line of floodlights on a single walkway/lighting rack running the central length of each bay. In the Thrybergh mill this technique resulted in a considerable reduction in steelwork construction and installation costs.

The arrangement of floodlighting in a continuous line offers several advantages over conventional high-bay systems. It does not suffer from loss of performance due to the atmospheric contamination of an open reflector surface, or a loss of illuminance over a large area if a source fails and it can simplify constructional problems.

The Choice of the Lamp

From the point of view of running cost the high pressure sodium lamp (SON) was clearly favoured.

SON lamps are now widely used in street lighting, in the lighting of heavy engineering shops, goods-yards, docks and various large areas where colour rendering is not of prime importance. Until recently SON lamps have taken the form of conventional single ended discharge lamps, but the development of the SON-TD a double ended linear version, offered considerably more scope in the design of a linear floodlighting system.

A SON-TD has a conventional alumina arc tube sealed inside a quartz jacket, the space between the two being evacuated. The quartz dimensions are such that the lamp length is the same as the standard 1500 watt tungsten halogen and the 1600W linear metal halide lamps. The SON-TD makes use of a very reliable starter using a high voltage pulse applied by an ignitor to ensure immediate striking. It takes 4 to 5 minutes to run up to full brightness and will normally restrike within 1 minute of extinction rapidly regaining full light output; a considerable improvement on the restriking times of mercury discharge lamps. The 400W lamp has an initial light-output of 47,000 lumens the lighting design lumens being 42,000 and a useful life of 6000 hours.

Choice of luminiares

The need to provide an even spread of light on the floor area of the mill led to the use of a luminaire having a wide horizontal but controlled vertical beam spread.

The Haline floodlight chosen had originally been designed and developed as a stock item for use as a 1500 watt tungsten halogen unit and proven in use in the field over many years. Having been designed to accommodate 1500 watts in ambients up to 25°C the luminaire could operate with the 400 watt SON-TD in an ambient as high as 40°C.

The luminaire has a one piece reflector/body of extruded aluminium one side of which has an asymetric facetted reflector profile, the rigidity and accuracy of which guarantees consistence of optical performance.

Feasibility

The horizontal plane illuminance considered for the installation was an average of 350 lux. This represents good current practice, taking into account that it would be a modern windowless interior, that there would generally be low reflectance and contrasts and that any mistakes in perception could be dangerous.

Initial calculations showed that even illuminance could be achieved by two rows of floodlights mounted back to back on either side of the walkway down the centre of each bay at four metre intervals. This spacing was slightly decreased after the trial installation had been made to suit the structure of the new mill. A mounting height of fifteen metres was considered typical as it was 75% of the height of the mill.

Use of a scale model

It will be appreciated that in projects such as this there must be the best possible liason and communication between engineers in the field,

research and development engineers within our own company and also with the clients engineering design unit staff and because of certain requirements put forward by the clients engineers, a scale model of a section of the main mill bay was constructed in our laboratories at Enfield to carry out tests on possible shadowing caused by large vertical units i.e. mill stands, etc. To simulate the lighting system, holes were made in the top section and a fluorescent tube mounted externally provided the source.

The model showed that the inter-reflected light within the area would cause sufficient light to fall onto surfaces receiving no direct light. This indicated that the shadow problems would not be at all severe and confirmed the feasibility of the system.

Visual Comfort

The control of glare was of high priority but the amount of research and experience on the evaluation of glare from single sources, particularly in the arrangement of the proposed installation was very limited. In addition the amount of discomfort seems to vary from person to person, some people having a greater sensitivity to glare than others. Glare always results from areas of high brightness in the visual field. If there is a direct interference with vision it is called 'disability glare'. If there is no direct interference with vision but discomfort or irritation the condition is called 'discomfort glare'. In practice both these conditions may arise from the same glare source, but discomfort glare is the more common and is probably present to some extent in every installation. Research workers describe the effect of disability glare as the reduction in the sensitivity of the eye to contrast; saying that the "contrast threshold" of an observer increases in its presence.

Veiling luminance for the proposed installation was calculated from fourteen luminaires in the field of view and found to be 0.5 cd/m² . For even a very pessimistic estimate of background luminance, say 10 cd/m² the rise in threshold contrast would be 2% or less.

The Trial Installation

In order to check these calculations a site trial was conducted in another mill using 10 pairs of fittings in the proposed arrangement. Once again satisfactory results were obtained. Although environmental detail at the trial installation differed from the proposed installation the mounting height, scale and geometry of the layout was similar.

For this trial installation twenty flood-lights were erected according to the proposed installation and a series of full scale subjective experiments conducted, in order to assess the levels of illuminance, colour effect and general performance. By this means it was possible to evaluate the scheme as a viable alternative to normal high bay lighting techniques and allow the clients engineering personnel to determine the colour scheme for internal paint finishes and suitability of the light source when used with closed circuit T.V. systems.

Shadowing produced by the in-line arrangement was found to be very acceptable. The spacing to mounting height ratio was such that the installation was tending to a line source. This breaks down direct shadows which are therefore less dense, or severe, than those produced by a conventional high-bay installation in a similar environment. In addition coloured embossed metal labels are used widely in a steel mill and problems of reflected glare arise when trying to read these under conventional high-bay lighting. It was found that this problem diminished under the in-line floodlighting system. The aiming angles of the luminaires were varied until an acceptable compromise between glare and uniformity across the bay was found. This was considered to be when three floodlights per side were at 26° elevation and one at 4°.

A party of production operatives and engineers was asked to assess and comment on such matters as colour, level of illuminance, uniformity and visual comfort. The in-line floodlighting system was viewed favourably and considered a viable alternative to the normal high bay scheme.

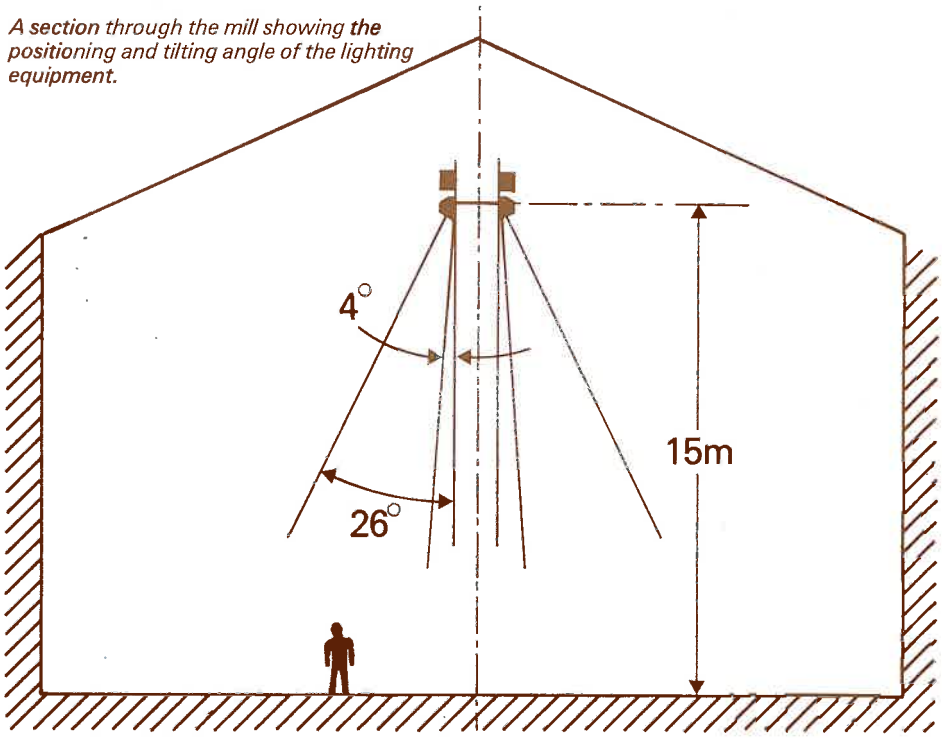
Conclusion

As a result of all the design and test work carried out, Thorn Lighting Ltd. received an order specification for the lighting at Thrybergh Bar Mill. The scope of contract called for the following parameters:

1. Design of the lighting scheme to achieve overall performance in terms of the specification.
2. Manufacture and supply of light fittings lamps and control gear to meet the requirements of the specification.
3. To advise on all technical aspects associated with the lighting installation during the period of installation by the electrical contractors.
4. To carry out "on site" acceptance tests as laid down in the specification.

During the course of construction of the building and the installation of the lighting equipment the authors have made numerous visits to site to check on the mounting and angular position of fittings and lamp and gear operation. Illuminance readings have been taken to ensure that the design details given to the client were substantiated. In addition to the lighting equipment described in this article a substantial quantity of other types of Thorn fittings were used throughout this large project.

A section through the mill showing the positioning and tilting angle of the lighting equipment.



Lighting a Baroque Ceiling

The painted and gilded ceiling, the work of Paul Veronese, is splendidly displayed by the light of Haline fittings mounted on the window sills. Paintings on the walls, by Tintoretto and others, are lighted in the same way and by 150W Coolray spotlamps.

L Castellani
Signor Castellani is Product Manager of Thorn's Italian Lighting Company; the Società Industriale Vicentina Illuminazione SpA.

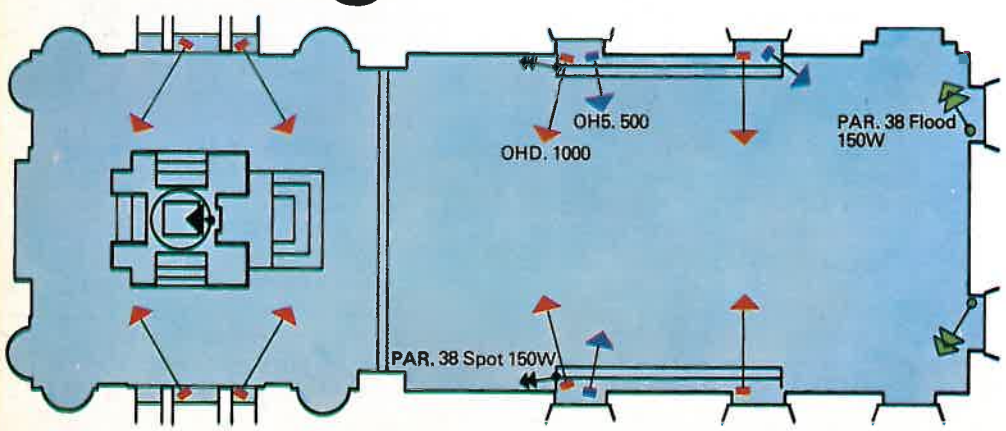
The church of SS Giovanni e Paolo in Venice is not only notable for the tombs of the Doges, it also contains a number of famous paintings and the chapel of the Rosario has a carved and frescoed ceiling painted by Veronese and Tintoretto. The high narrow windows of the chapel do not admit enough light for the works of art to be clearly seen and Thorn's Italian Company was called in to design a suitable lighting scheme.

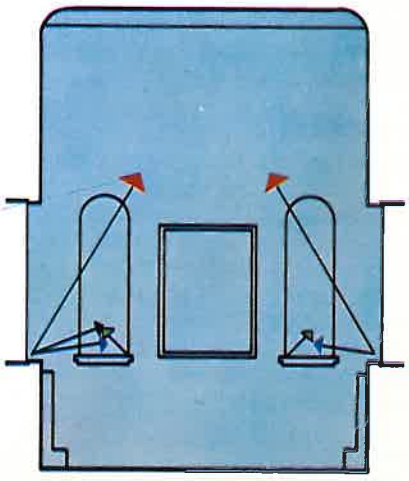
The problem differed from that of lighting an art gallery in three major respects. First that the objects to be lighted were not confined to the walls, but included the ceiling, secondly that the total appearance of the room had to be considered, and thirdly that more care than usual had to be taken against problems of reflections in the surface of the pictures and that where lamps were employed at close range it was necessary to guard the delicate works of art from overheating.

It was decided to mount the greater part of the lighting equipment in the window embrasures, so that the distribution of light would be similar to that of natural daylight. Fortunately the sills of the tall narrow windows were well above eye level and this aided the concealment of the lighting equipment as well as ensuring that reflections of the lamps in the dark surfaces of the oil-paintings on the walls were directed away from the observer.

Eight Thorn Haline (OHD 1000) floodlights housing 1000W tungsten halogen lamps were used to light the ceiling, while five of the smaller 500W type (OHS 500) cast light across the chapel to light the walls.

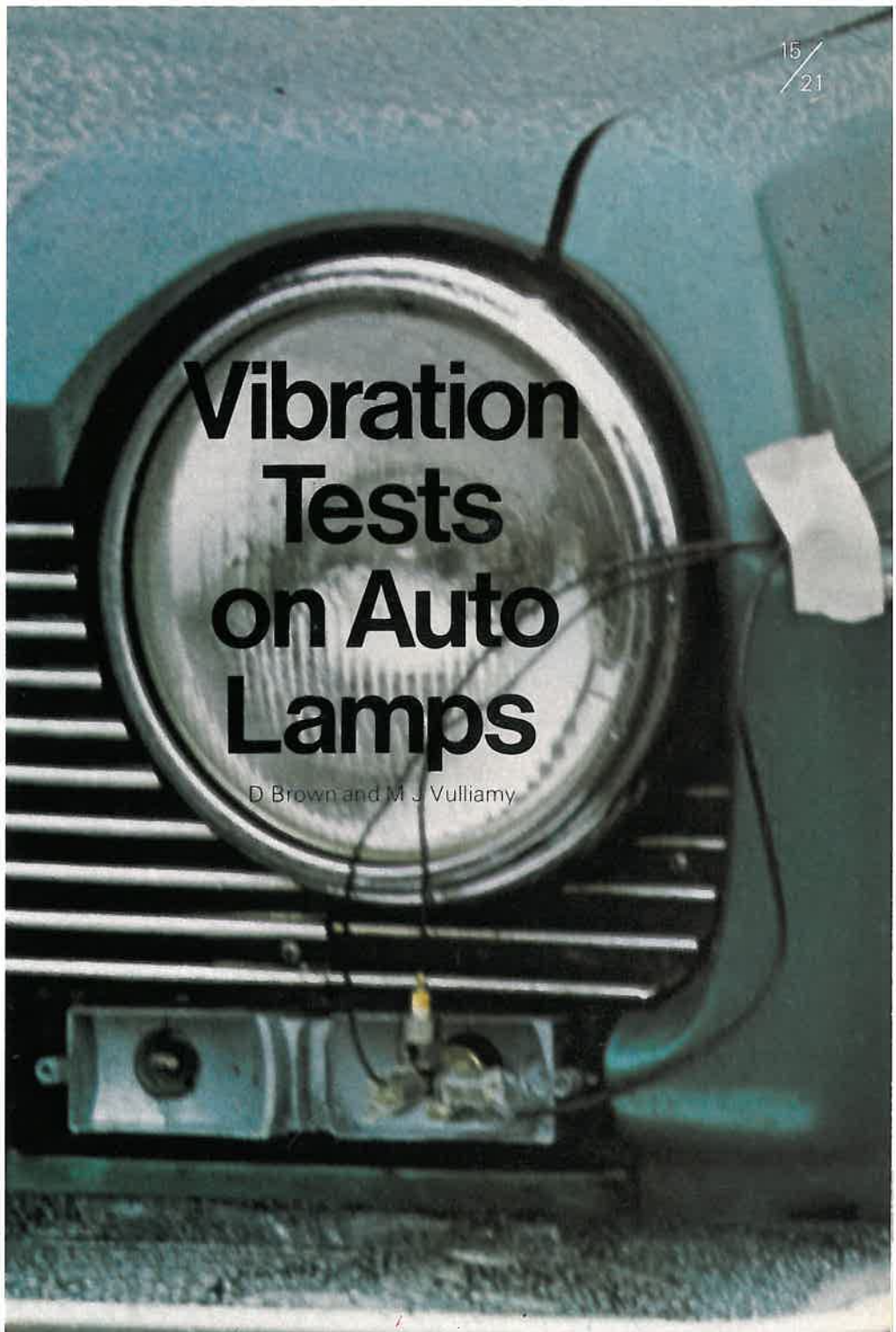
In situations where extra light was needed, these floodlights were supplemented by nine PAR 38 150W 'Coolray' lamps in DSU 150 housings. Dichroic lamps were specified to avoid the risk of overheating the paintings in situations where a short 'throw' was unavoidable: they were also easily concealed — an important point in so mannered a style of architecture.





Vibration Tests on Auto Lamps

D Brown and M J Vulliamy



'Test Rigs' applied to a motor car for trials under actual conditions. Note the cables by front headlamps. Below can be seen the recording apparatus mounted on the back seat.

Mr Brown and Mr Vulliamy are engineers in the lamp engineering department of Thorn Lighting at Leicester, specialising in miniature lamps.

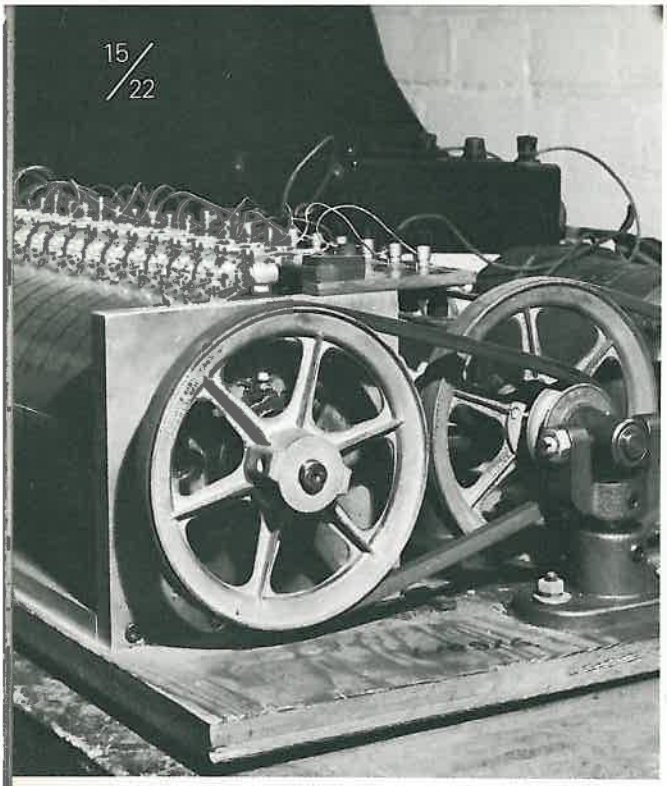
Automobiles are designed to minimise the noise and discomfort vibration felt in the passenger compartment through the controls and seats, but less effort is made to reduce vibrations at the extremities of the car which are caused mainly by body section resonances set up by the rough texture of a typical road surface. The most fragile components on a vehicle, the lamps essential for driving and signalling, are usually positioned at the extremities, while others used for monitoring the state of the engine and electro-mechanical systems are still subject to vibration but at lower levels. Auto lamps are invariably constructed with tungsten filaments which, after use at the efficiency and high colour temperature required are very brittle and susceptible to vibration and shock damage. Vibration is inherent in every type or make of vehicle and unless minimised can cause premature failure of lamp filaments with possibly disastrous consequences.

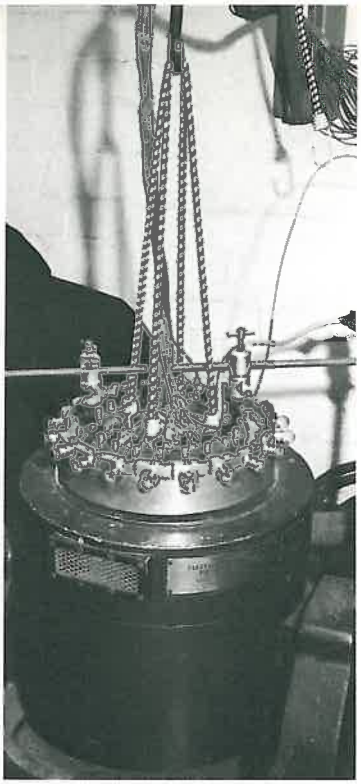
Every component in a lamp has a natural resonant frequency. If it is exposed to vibration at that frequency large vibratory movements can be induced in response to comparatively small forces. The random frequencies generally found in vehicles are mainly from 20-400 Hz, and are the result of road irregularities transmitted by the tyres and modified by the suspension, mixed with the vibration from the engine and gearbox. It is obvious therefore that components must be designed with resonant frequencies outside the service range, or where that is impossible, designed so that resonances are restricted as much as possible and the lamp is strong enough for the mechanical life to exceed the electrical life bearing in mind the probable on/off ratio.

Endurance testing simulating modes of vibration found in all normal environmental conditions can be used to establish or anticipate lamp life, so that the design of a lamp can be modified to give it the ability to withstand service conditions throughout its electrical life.

The need for a test

Increased interest in safety legislation and the commercial consideration of warranty costs have led to a demand for a 'realistic' vibration test based on actual vibration





Far left: The 'Michigan Impact Tester'. The random results from this piece of apparatus are of very little practical value.

Left: An electrodynamic vibrator head that tests two dozen lamps at a time over a range of accurately measured frequencies.

conditions capable of discriminating between good and bad lamp designs. A selective test is of particular interest both to the manufacturers and operators of heavy commercial vehicles which generally use 24 volt electrical systems. Such lamps are inherently weaker than 12 volt lamps due to the smaller diameter and greater length of tungsten wire required for the filament. Only the best of heavy duty versions of 24 volt lamps, with constructional or material changes such as intermediate supports or thoriated tungsten filaments which have a greater cold strength, compare in mechanical strength with the 12 volt version although their electrical life is of course identical.

The Need for Realistic Test Equipment

The lack of a realistic test has led to a situation where each major lamp user can have his own mechanical tester and specification requirements, so that the lamp manufacturer may find he is testing a particular lamp in several different ways to satisfy individual customer requirements. Typical of such tests is the Michigan impact tester, a revolving wooden cylinder with four offset quadrants on which the test lamps are rattled up and down at random. This was originally developed for the US Defence department as an aid to designing lamps for tracked military vehicles. In spite of its irrelevance to wheeled vehicles, it has been included as a specified test for heavy duty vehicles by the Society of Automotive Engineers in the USA and in some cases is being applied to standard auto lamps. The total lack of reproducibility between 'identical' testers and the fact that results on the tester cannot be correlated with field endurance trials on vehicles are serious objections to its use.

The search for a 'realistic' approach has resulted in a proposed test using an electrodynamic vibrator and applying a vibration programme based on the environment that auto lamps are likely to meet in service.

Environmental Study

Vibration measurements have been carried out by Thorn Lighting and other manufacturers on a range of vehicles travelling at different speeds over all available road surfaces e.g. tarmac, concrete, cobbles and over various hazards e.g. potholes cattlegrids and level crossings. Transient effects such as the slamming of bonnet and boot and closing of doors were also recorded. Measurements were made using accelerometers screwed into a dummy lamp rigidly attached to the vehicle bodywork at each lamp position. A portable 4-channel recorder was used to record the three axes of vibration and a speech channel was provided to make notes of road speeds and effects.

The recordings were analysed in the laboratory and a vibration level frequency spectrum was obtained for each vehicle and road combination. From these spectra envelope curves were drawn encompassing all the frequency and vibration levels likely to be met by auto lamps under service conditions.

In order that the widest possible experience should be considered in this exercise the whole question of service characteristics was studied by a panel of engineers representing the major European interests. These investigations enabled a summary to be made of the conditions obtained across a range of vehicles and environments and this forms the basis of the test recommendations currently being evaluated.

Testing

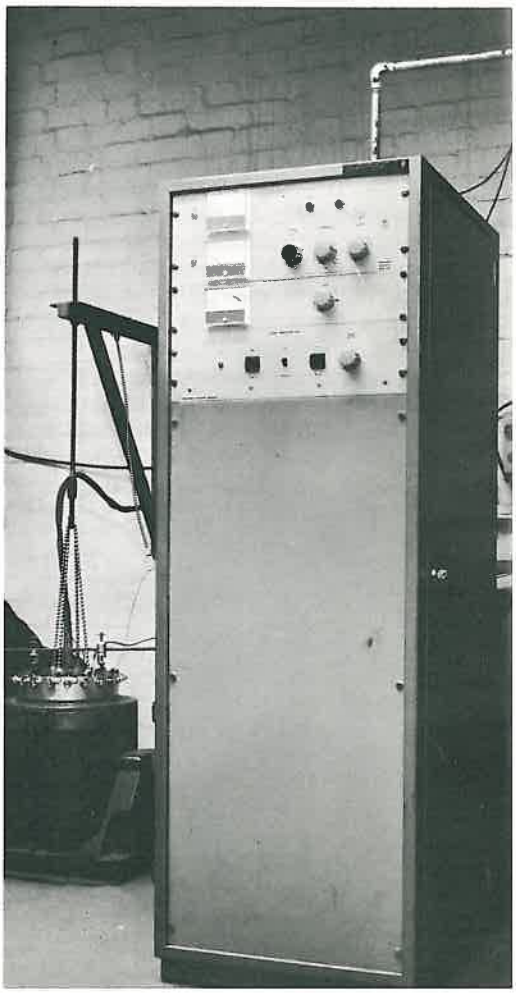
Electrodynamic vibration generators are specified in all types of present day test requirements, although there are three normal methods of use:

a) the frequency sweep test
b) the wide band random vibration test
c) the narrow band random vibration sweep test.

The frequency sweep test is used for endurance testing and consists of feeding a vibrator with a sinusoidal wave form of small power at a slowly changing frequency between preset limits. Resonances in the test specimen are compensated for by means of a feedback control circuit as the vibrator sweeps through the resonant frequencies.

The wide band test on the other hand consists of applying wide band random noise of constant power to the specimen thus exciting all resonances simultaneously. This method has the advantage of being a close approximation to the random vibration found in road transport. It has the disadvantage of high cost of equipment due to the complex compensating circuitry required.

The third method is a compromise between the two and uses a sweeping narrow band of random vibration; this is a much closer approximation to the



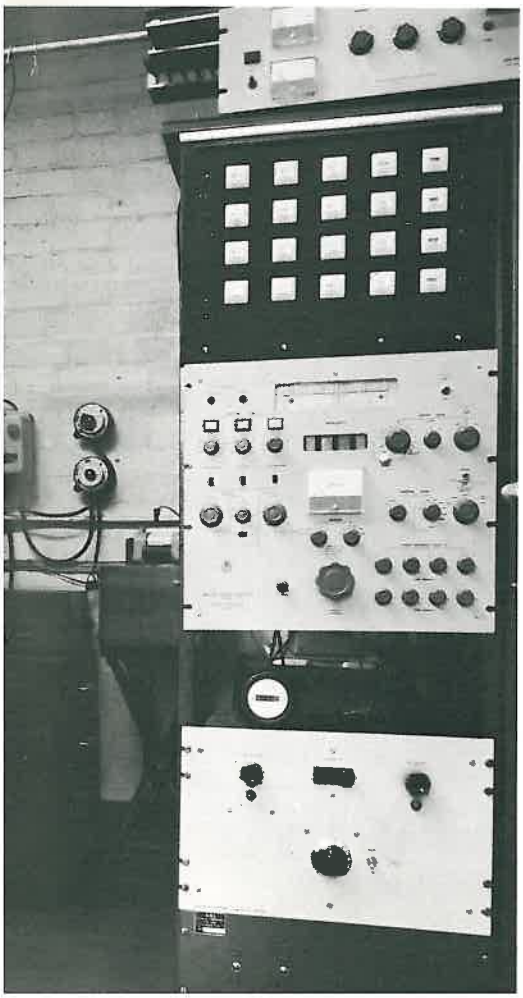
One of the authors checking the vibration tests made under actual road conditions. The final print-out shows frequency and amplitude of vibrations experienced at various parts of a vehicle.

Below centre: The electronic controls and recording devices are housed in these cabinets — the vibrator head can be seen to the left of the picture.

environment being simulated while the cost of equipment is only a little higher than for the sinusoidal frequency sweep test.

With all these methods there are certain basic equipment requirements. The waveform generator should be accurate, stabilised and fully programmable for the test specification. The amplifier must have an adequate reserve of power to shake the vibrator at the required test level without introducing any distortion. The vibrator itself must be powerful enough to carry a resonance-free jig containing twenty to twenty five test lamps and to provide the highest level of vibration required in a simulated shock test. This is a high level vibration test of short duration (5-10 min.) carried out on the lamps which survive the main vibration test. It is intended to take account of the impacts of bonnet, boot and door closures. The main test is carried out for 20 hours, giving at least 107 reversals of stress.

It is recognised that equipment cost will have an influence on the acceptability of the new test and for this reason it is proposed that either the narrow band random noise or the sinusoidal technique be used. Interchange tests are being carried out by the major European lamp manufacturers to determine the vibration test levels at which comparability of results between the two methods are achieved.



Approval

Due to the provisional nature of the present test procedures, final compliance levels have not been established, but it is visualised that a survival percentage of 80% at 20 hours might be adopted.

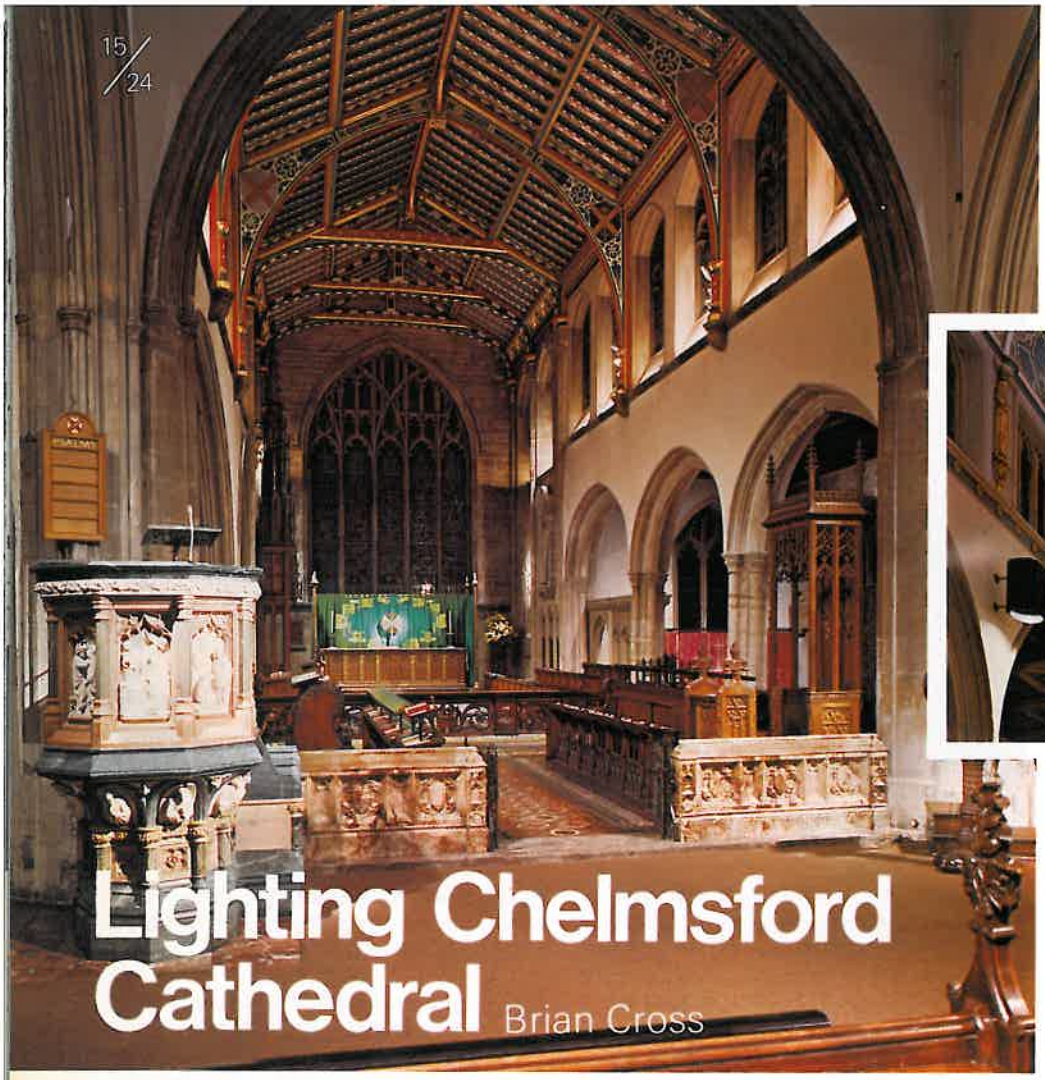
Following trials on various lamp types from several manufacturers, tests are now in progress to establish the relationship between vibration test results and life under service conditions.

Results of laboratory tests have already led to modifications to the design of lamps which can then be shown to give consistently better results when submitted to this form of testing. Controlled tests on vehicles using lamps with these modified constructions have shown a greater degree of reliability in service compared with the normal standard design of the same lamp type. To give two examples, it has been established that the 24 volt 5 watt lamp using thoriated wire (types 247 and 248) and the 24 volt 21 watt with a filament support (types 290 and 291) give several times the service life than had previously been achieved.

Conclusions

It is clearly very desirable to achieve a measure of agreement between lamp manufacturers and users on an accepted test, which can assess the anticipated behaviour of lamps under service conditions. Apart from rationalising all the individual test requirements of the lamp users, there would be confidence that the more consistent results obtained in the test laboratory would have a factual relationship to the behaviour of lamps in service.

It is desirable too that such a test for the evaluation of shock and vibration resistance of auto lamps should be recognised as meaningful on an international basis and the result of the work being carried out by the study panel referred to earlier should lead to the inclusion of vibration test requirements in the appropriate international specifications.

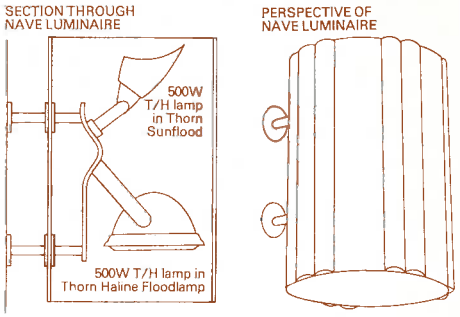


Lighting Chelmsford Cathedral

Brian Cross

Left: A view of the chancel. Note how the modelling of the pulpit is emphasised by the light from a low-voltage spotlight.

Below: A detail of the painted plaster ceiling of the nave. A drawing of the special luminaire is seen below it.


SECTION THROUGH NAVE LUMINAIRE
500W T/H lamp in Thorn Sunflood
500W T/H lamp in Thorn Haline Floodlamp
PERSPECTIVE OF NAVE LUMINAIRE

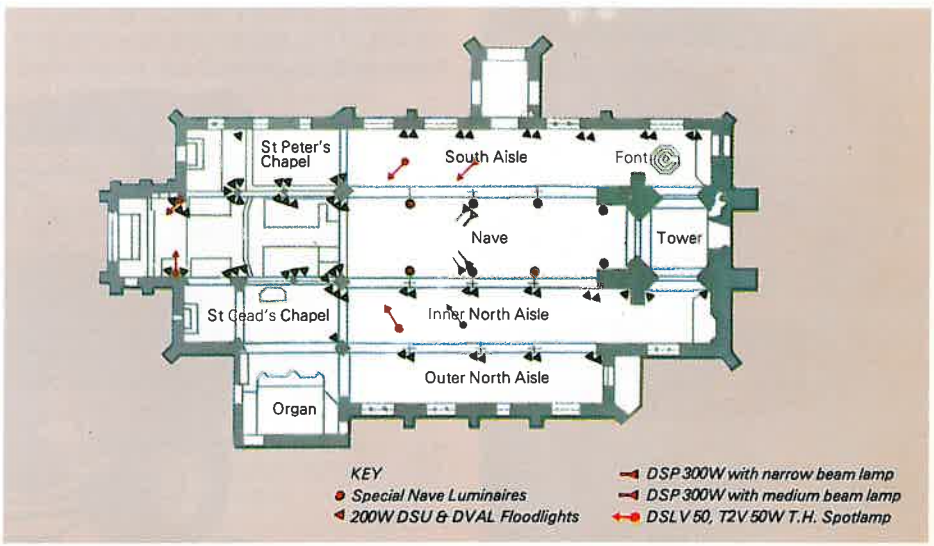
Mr Cross is a Senior Project Engineer at Thorn Lighting's London office at Charlton.

Although it is the most populous diocese in England, Chelmsford disputes with Oxford the distinction of having the smallest cathedral. It was the parish church of the town until it was made the cathedral of a new diocese in 1914. The date of the original building is uncertain; but most of what can be seen today is 15th century work, except for the nave ceiling, a magnificent example of early gothic revival plaster work, installed after the nave collapsed in the year 1800. It is perhaps, the most distinctive feature of the church and any lighting scheme was bound to take it into account.

As most of the building could be lighted with standard equipment, concealed by structural features, the chancel, side chapels and the three aisles of the nave are lighted by groups of 200W lamps in DSU 150 spotlight fittings, concealed as far as possible by beams and arches from anyone looking towards the altar, but shining directly onto pews and gangways, to give the maximum light for the current consumed. Focal points, are picked out by low-voltage spotlights using tungsten halogen lamps.

This technique allows the light to 'flow' naturally from south to north as it would in daylight and also for areas of wall to be lighted to give brightness contrasts as well as to emphasise modelling on monuments and statuary, and emphasise important features such as the pulpit and altar.

To light the nave special luminaires were designed. These are large metal housings of contemporary design containing 500W tungsten halogen lamps in 'Haline' floodlight fittings. Those on the north side light downward only, but on the south, a 500W 'Sunflood' is installed in the top of each housing pointing upwards to light the ceiling. By confining this lighting to one side the modelling of the ceiling is clearly revealed. It was originally suggested that luminaires should be painted to match the stonework and this is now being considered. It is possible to dim the downward lights in the nave and nave-aisles, in the chancel and each of the two side chapels independantly of one another. The upward lighting in the nave and low-voltage spotlights that pick out salient features are, however, not dimmer controlled. The switchboard and dimming circuits were designed and manufactured by Thorn's Theatre Lighting Division, and the whole of the wiring and lighting equipment installed and wired in M.I.C.C. cable by Blakebrough and Warren Ltd. of Westcliff-on-Sea.



A plan of the cathedral, showing the position of the lighting equipment.

Modern Lamps: Efficient Light Sources

M A Cayless

Dr Cayless is Head of Lamp Research Thorn Lighting Ltd.

The latest development in the tungsten halogen field is this 300/500W 'Sunspot' projector designed around a single-ended mains voltage lamp. A special heat sink is used to overcome overheating at the lamp pinch.

Origins

The economic production of light from electricity has been the subject of intensive research and development since the original invention almost a century ago of the first practical carbon filament incandescent lamps by Swan in England and independently by Edison in the USA. Before this, investigators had produced light by heating wires to incandescence with electric currents, but only briefly and ineffectively. Arc lamps had been established for some years but were clumsy and unstable. Two technological developments paved the way: the realisation of large scale production of electricity by machinery and the invention of much improved vacuum pumps.

It seems that Swan was the first to produce his lamp, which he demonstrated in December 1878, but did not patent until 1880, whereas Edison produced his and obtained a patent in 1879. However, Swan caught up by making the next important advance, extruded nitrocellulose carbon filaments. This spirit of healthy international rivalry has been present ever since.

Improvement of lamp efficacy has always been a preoccupation of the lamp development scientist, so the current emphasis on conserving energy by producing light more efficiently is nothing new to him, though he may find the present wide-spread public concern about the direction of his efforts something of a novelty.

As an indication of the progress which has been made, early carbon filament lamps produced about two lm/W, whereas the modern gas-filled coiled-coil 100W domestic light bulb produces 13.3 lm/W. On the other hand, in 1934 the most efficient low pressure sodium discharge lamp, used for street lighting, produced 65 lm/W, whilst its present day equivalent gives as much as 170 lm/W.

New Developments

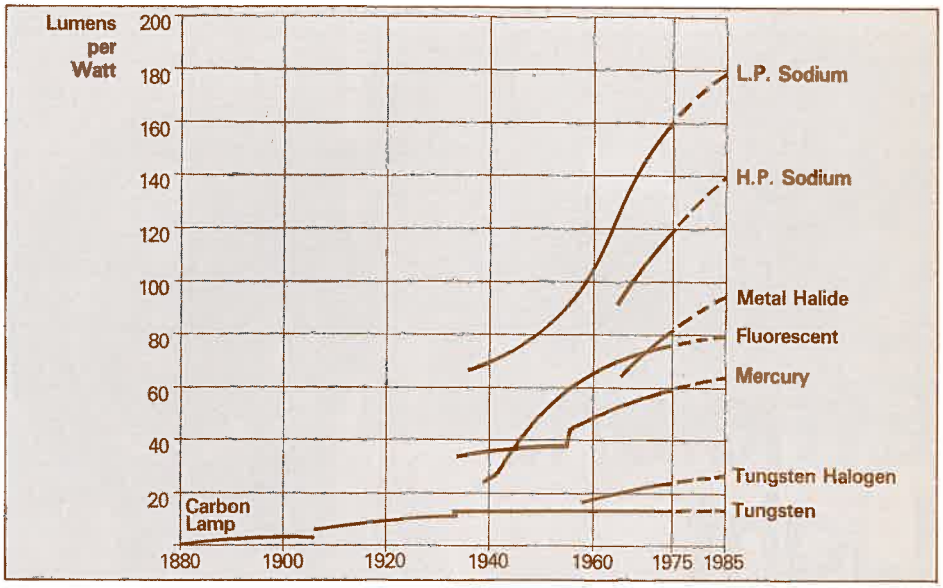
The graph shows how continuous steady progress has been supplemented by substantial jumps when significant discoveries have been made.

Although incandescent lamps, which nowadays have tungsten filaments, are much less efficient than discharge lamps, they have the great merits of simplicity, cheapness, compactness, and acceptable colour properties. Discharge lamps are much more efficient and last much longer, but are more expensive, often bulky, and require electrical control gear for their operation. Some, like the fluorescent lamp and the colour-corrected mercury discharge lamp, have excellent colour properties, but others achieve their superior efficacy at the expense of colour. In particular, the low pressure sodium lamp, whose orange-yellow light is seen illuminating our streets and motorways, obtains its unapproachably high efficacy at the cost of complete absence of colour discrimination. Its light is a monochromatic yellow, of one wavelength only, so that the colours of

Improvement in the efficacy of lamps. The curves show the maximum efficacy of each type in regular use; other sizes, colours etc. may not reach these values.

Facing page: Research into the characteristics of an experimental high pressure sodium lamp. Thermal, electrical and optical measurements are being made using equipment linked to a computer. The spectrum of the lamp can be seen being traced on the left of the picture.

Facing page, right: Translucent alumina ceramic discharge tube in a high pressure sodium discharge lamp.



objects lit by it cannot be revealed.

Much present-day research is aimed at producing new types of discharge lamp which will give efficacies approaching these but with acceptable colour rendering properties. These will make a substantial contribution to energy conservation by enabling high efficacy discharge lamps to be used in situations where poor colour, coupled with size, complexity and cost, have hitherto precluded them; for example commercial and industrial interior lighting, and possibly, eventually, domestic lighting. Simplification, or even elimination, of the control gear needed would vastly increase the range of such possibilities.

Remarkable developments have been made in this direction over the last few years and some of the results are already to be seen around us. High pressure sodium lamps with their attractive golden white colour and efficacies in the region of 120 lm/W are now lighting many town centre areas, and metal halide discharges with excellent colour and colour rendering properties and more modest but still relatively high efficacies around 80 lm/W are increasingly being used in lighting shops, hotels, offices, public squares, sports stadia, outdoor television broadcasts and so on.

There will only be room in this article to touch upon one or two of the more interesting of these new developments.

Tungsten Halogen Lamps

The ordinary incandescent filament lamp is limited in life and efficacy primarily by the evaporation of the hot tungsten wire, which gets thinner and eventually burns out. Also the evaporated tungsten is deposited on the inside of the bulb and darkens it. The rate of evaporation can be reduced by introducing an inert gas, such as argon or nitrogen but the pressure is limited by the strength of the bulb.

It has long been known that the deposition of tungsten vapour on the glass can be prevented by introducing halogen, a chemically active gas such as iodine or bromine, which combines with the tungsten, but the problem was how to do this in a controlled and effective manner. In fact a whole complex cycle of chemical and physical processes is involved, and the development of the modern tungsten halogen lamp, which combines the simplicity of the filament lamp with efficacies from 20 to 30 lm/W (see Table below) has resulted from our understanding of these subtle processes and finding ways of using them effectively in a lamp.

In the early tungsten halogen lamps crystals of iodine were simply introduced into the silica glass envelope, but this only works for a very limited range of lamps. Modern halogen lamps contain a variety of compounds of iodine and bromine, with formulae like CH_2Br_2, CHI_3, $(PNBr_2)_3$, each designed to optimise the performance of a particular lamp type.

Performance of some typical tungsten halogen lamps, compared with that of the ordinary non-halogen 100W light bulb.

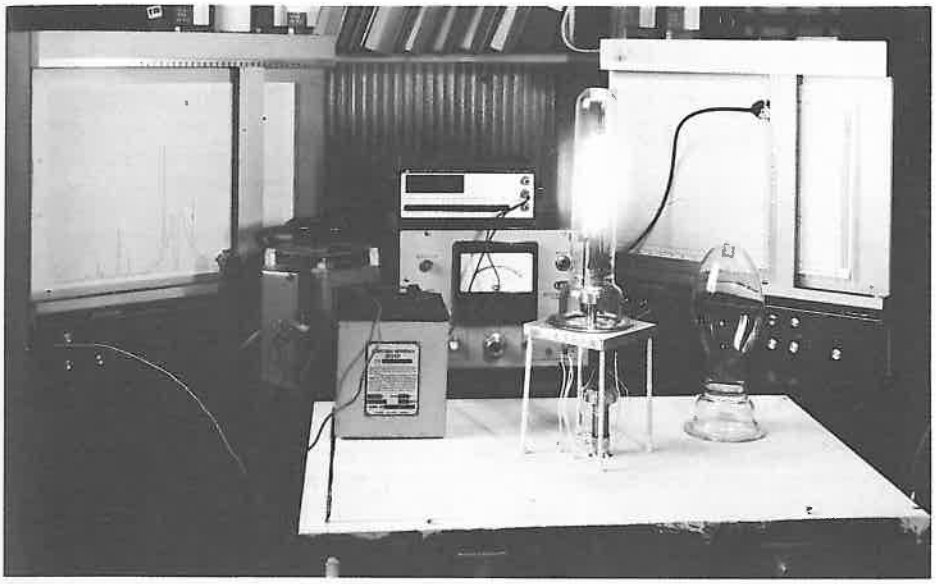
Type	Power (W)	Efficacy (lm/W)	Filament Temperature (°C)	Life (hr)
Non-Halogen Lamp	100	13.3	2500	1000
Linear Floodlamp	1000	20	2700	2000
Automobile Headlamp	55	25	2900	250
Projector Lamps	150	33	3100	50

A good deal of present research is aimed at developing the use of another halogen, fluorine, which promises even better performance, but which is highly reactive and is more difficult to control. This will probably be about the ultimate for an incandescent lamp. Even at its melting point, 3410°C, we should not expect more than about 50 lm/W from a tungsten filament. Other materials are being explored, but very much greater efficacies are not expected. We therefore look to discharge lamps for them.

Mercury Discharge and Fluorescent Lamps

In a discharge lamp a stream of electrons passes from a cathode to an anode through a mixture of gases or vapours contained in a transparent tube. During their passage through the vapour, the electrons collide with the atoms of the vapour and "excite" some of them so that they radiate light. If the vapour is at a low pressure (below about 1/100 atmosphere) the radiation produced is in sharp spectral lines of single wavelengths characteristic of the atoms concerned. Thus mercury vapour produces light from single lines in the yellow, green, blue and ultraviolet; sodium vapour produces visible light from only two very close lines, the "D lines", in the yellow, and also in the infra-red.

Until the 1960's discharge lamps nearly all contained either mercury vapour, or sodium vapour at a very low pressure, together with some inert gas which does not produce light. Since the yellow sodium lines are close to the peak of the sensitivity of the eye, low pressure sodium lamps can be very



efficient, provided that the infra-red lines can be suppressed. This is now done by using a filter which reflects the infra-red radiation back into the discharge, and was one of the main developments leading to the spectacular increase in the efficacy of low pressure sodium lamps already mentioned.

In the case of mercury at a low pressure, the most efficient radiation is in the ultra-violet, and advantage is taken of this in the fluorescent lamp, in which the inside of the tube is coated with a phosphor which converts this ultraviolet into visible light. By choosing the phosphor, a wide range of very good colour properties can be produced.

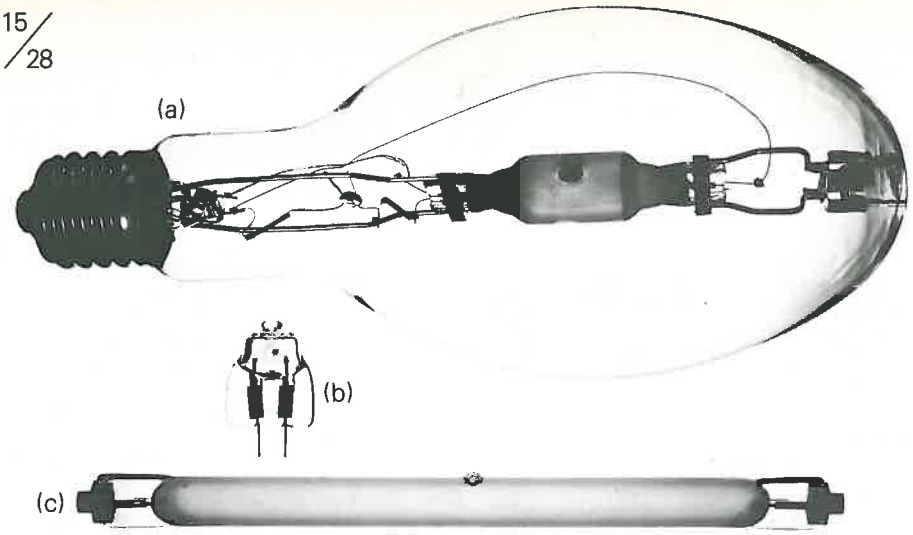
An alternative is to use a much higher pressure of mercury, approaching atmospheric pressure. To do this a much smaller discharge tube is used, which runs hotter, and is usually made of heat resistant fused silica glass. Several things then happen: the discharge becomes constricted to form a hot core surrounded by a mantle of cooler gas; the ultraviolet lines become suppressed and the visible lines enhanced, and also broadened into spectral regions. The discharge thus produces visible light directly: in the case of mercury the rather garish greenish blue light associated with early mercury lamps.

A considerable improvement is made by coating the surrounding outer bulb with a phosphor which produces, from the residual ultraviolet, some light in the red end of the visible spectrum to supplement and balance the green. These lamps are more compact and brighter than fluorescent lamps, but their colour properties are not quite as good because of the effect of the visible mercury lines. Efficacies of fluorescent lamps are typically 50 to 70 lm/W depending on colour, and colour corrected mercury discharge lamps about 55 lm/W.

The High Pressure Sodium Discharge Lamp

The idea naturally arose of trying to use sodium vapour at a higher pressure in a similar manner. Theoretical considerations suggested that other lines than the yellow D lines might be excited, to give a better colour. However, sodium vapour at a high temperature is highly corrosive and rapidly destroys all useable vitreous materials. Many years of research finally perfected a means of making discharge tubes from a translucent ceramic consisting of pure alumina, or sapphire. In Thorn's Stellox, the ceramic is polycrystalline, and scatters the light, but does not absorb it. More recently tubes have also been made from single colourless sapphire crystals, which are transparent. Both these kinds of tube are a triumph of technology: not only does the highly refractory tubing have to be made in the first place, but means of sealing electrodes into the ends which will resist sodium vapour at 700-800°C, and methods of actually constructing lamps from them have had to be devised. Well over 10 years intensive research and development were needed before satisfactory lamps for public use were made.

The results were astonishing. It was found that when the sodium pressure is increased to about a quarter of an atmosphere the yellow D lines are vastly broadened in a quite unexpected way, so that they extend over a wide part of the visible spectrum, giving an attractive golden white colour at quite



Metal halide discharge lamps. At the top is a 400W MBI lamp, with a clear outer bulb, without the phosphor coating of the MBIF lamp. In the centre is a 400W CSI lamp and at the bottom is a 1600W MBIL floodlighting lamp. The condensed halides can be seen inside the arc tubes.

high efficacy. Early lamps produced about 90 lm/W, but continued development has raised this to 120-130 lm/W for lamps now being made. These thus form an attractive alternative to the low pressure lamps when the highest efficacy is not paramount and some colour rendering is needed. They are thus finding increasing use for lighting town centres, whilst the low pressure lamps are used along roads and motorways further out. They are also used in industry where recognition of coloured labels or warning signs is essential.

Another form of high pressure sodium lamp provides a high efficacy alternative to tungsten halogen lamps for floodlighting purposes when colour rendering is not so vital. The Thorn SON TD lamp is a double-ended lamp designed to replace a standard 1500W tungsten halogen lamp, but produces 27% more light for only 1/3 of the power, and has three times the life. Because of the small diameter of the tube, very accurate control of the light is possible.

Metal Halide Discharge Lamps

An entirely different approach has been developed alongside the high pressure sodium lamp. Instead of trying to cope with highly reactive hot metal vapour, the metal is introduced in the form of a volatile compound, usually an iodide. (The discovery that this could be done effectively was also unexpected when first made.) When the discharge is operating, this dissociates into its elements in the hot core of the discharge, and the light characteristic of the metal is produced, whilst in the cooler outer part of the discharge the elements recombine to form the compound, which does not react with an ordinary fused silica glass tube. Thus conventional lamp making techniques can be used to produce high quality light sources with efficacies up to 80 lm/W.

The other great advantage of this type of discharge is that many different metals can be introduced in this form, and several may be combined in a single lamp to obtain a white light with really excellent colour rendering properties. For example the type "a" shown on this page contains the iodides of scandium, sodium, thorium and mercury, as well as the rare gas argon, and produces a white light suitable for high quality interior lighting suitable for shops, hotels etc. Further improvement can be obtained in the Thorn Kolorarc lamp by coating the outer bulb with a suitable phosphor, as in the case of the mercury lamp. The compact source CSI lamp (type b) contains the iodides of thallium, gallium, sodium and mercury, and produces light of a quality suitable for film projection, colour television, etc. Other mixtures are also used to produce special spectral distributions, including various ultraviolet and infrared wavebands, for special purposes such as colour printing, photochemical applications and catalytic processes. These are often in the linear MBIL form (type c) which is designed to be used, in a special fitting, without a glass outer jacket.

The Future

The theoretical limit to the efficacy with which electrical energy can be converted into white light with good colour rendering properties is about 200 lm/W. Some forms of low pressure sodium lamp can reach this figure, but only for monochromatic light. The high pressure sodium lamp is creeping up and further improvement can be expected over the next few years. The other lamps which produce good quality white light are still below 100 lm/W, so there is still plenty of scope for further improvement.

Research in the lamp industry concentrates largely on the physics and chemistry of the light-producing processes, and also on the materials which are used in lamp construction: the alumina ceramic arc tubes used in the high pressure sodium lamp provide a dramatic example of how progress has depended crucially on a development in materials technology.

At present a new type of volatile compound is under investigation for use in discharge tubes which forms chemical complexes in the vapour phase, and shows promise of producing high quality light at still higher efficacies. New materials for discharge tube construction based on other transparent refractory compounds (some of which, like sapphire, are also associated with gem stones), are likely to extend further the scope for using vapours which are known to be good light producers, but for which so far no constructional technology is available for fabricating lamps which use them.

In much of this work, the lamp industry collaborates closely with research carried out in Universities and Government Research Departments. At present a number of joint investigations are in progress, and full use is made of facilities offered by the Science Research Council and other supporting bodies.

Looking further into the future, long term research is directed at producing light by quite new processes, either quite unknown, or possible at present only in a laboratory environment or very inefficiently.

Metal Halide (MBIF) lamps were used to light the RAF museum at Hendon, one of the first non-industrial applications of this lamp in the United Kingdom.

Dans cette édition.

DEUX INSTALLATIONS D'ÉCLAIRAGE INHABITUELLES 2
I. Maclean et R. C. Aldworth

La réalisation des planchers des nouveaux bureaux des Etablissements METAL BOX COMPANY LTD à Reading, nécessitait des plafonds en caissons profonds. Il fut décidé de les utiliser pour y loger des luminaires spécialement conçus, à lampes fluorescentes au mercure dans des vasques en verre opale.

Etant donné qu'on ne pouvait les séparer des caissons les renfermant, ces luminaires ont été soumis à des essais photométriques et physiques à l'intérieur d'un caisson spécifique par les laboratoires de la Société THORN LIGHTING à Enfield: les ampoules en verre par contre, furent soumises aux essais de résistance au choc thermique à l'usine FRYGORS en Suède.

L'utilisation des plafonds en caissons crée un effet intéressant de lumière et d'ombre et brise la monotonie des grandes étendues de bureaux.

Le jeu de payme à partir duquel le tennis sur gazon est né, se joue encore en Grande-Bretagne. Un des courts couverts les plus renommés est celui d'Hampton Court près de Londres, construit par Henri VIII et sur lequel il a joué en 1530.

Les murs et le plancher noirs du court, sur lesquels tranchent uniquement les barres vitrifiées blanches à claire-voie, exigent un éclairage indirect car les faisceaux directs causeraient un trop grand éblouissement.

La luminosité recommandée pour un jeu de ce genre, analogue au squash, au badminton ou au tennis sur gazon, est de 300-500 lux ce qui est actuellement assuré par 36 lampes SON/TD de 400 W avec des projecteurs SONline sous une charge globale de 16,35 kW. Les membres du Royal Tennis Club d'Hampton Court soutiennent que leur court n'est pas seulement le plus ancien mais le mieux éclairé des courts de vrai tennis du monde.

LE PRIX 4
R. Forster

Le prix ou le coût effectif d'un projet d'éclairage provient de la combinaison de deux exigences fondamentales: la détermination de la qualité et de la quantité de lumière requises pour obtenir le meilleur rendement en matière de productivite et de satisfaction du personnel ainsi que le choix et l'application de la meilleure source de lumière et du luminaire.

Quoique l'éclairage ne représente qu'un des facteurs en matière d'environnement menant à une productivité améliorée, c'est en effet une donnée importante. C'est un fait qu'un meilleur éclairage peut accroître la productivité et le contrôle de la qualité, réduire les accidents, améliorer la sécurité, réduire l'absentéisme dû à une fatigue oculaire et améliorer les conditions de travail; en dernière analyse, toutefois, c'est bien l'usager et lui seul qui puisse évaluer les avantages qu'il tire de ces améliorations.

Le coût global d'une installation d'éclairage se compose du coût du capital principal, des frais annuels d'exploitation et d'entretien.

Le premier comprend le coût des luminaires, le premier jeu de lampes et le montage. Il y a également lieu de tenir compte de la durée de vie estimée de l'installation y compris l'amortissement des immobilisations. Il faut aussi tenir compte du coût de la consommation annuelle de courant et du remplacement des lampes (le premier étant toujours le plus onéreux). Etant donné l'augmentation constante du coût de l'énergie, l'utilisation de la lumière du jour, au lieu ou en supplément de l'éclairage artificiel ne doit pas être négligée.

Le troisième point à considérer, celui de l'entretien est lié au remplacement en série des lampes. Un luminaire sale donne moins de lumière mais consomme par contre la même quantité d'énergie qu'un luminaire tenu propre; le remplacement des lampes usagées au fur at à mesure est plus coûteux en main d'oeuvre que le remplacement en série. Les économies réalisées en consommation de courant résultant du remplacement du matériel existant sale ou en mauvais état suivi d'un entretien régulier et le remplacement en série de lampes, peut rembourser l'immobilisation en un temps remarquablement court, parfois en un délai aussi court que quatorze à dix-huit mois, environ 10% de la durée de vie moyenne d'une installation. Des exemples de telles économies dans le cas d'installations complétant cet article.

FACILITÉS POUR LES RECHERCHES EN MATIÈRE D'ÉCLAIRAGE 7
A. H. Willoughby

La situation presque unique des Etablissements THORN LIGHTING aussi bien comme producteurs en gros de lampes que d'accessoires y compris les luminaires, leur permet de développer les sources de lumière en parallèle avec le développement de ces luminaires et de procéder à des modifications au fur et à mesure de l'élaboration.

La Société possède deux laboratoires de recherches et de développement, un à Leicester, l'autre à Enfield; chaque laboratoire est en liaison étroite avec les usines du voisinage.

Jusqu'à il y a peu de temps, les laboratoires d'Enfield n'étaient que piètrement logés dans les anciens laboratoires ATLAS, ou dispersés dans la zone industrielle; le nouveau laboratoire, conforme aux exigences visées, abrite toutes les activités décrites dans le présent article.

Les laboratoires pour le développement des luminaires sont conçus de manière à assurer une gamme très étendue de luminaires THORN LIGHTING conformes aux exigences légales d'un certain nombre de pays en dehors de la Grande-Bretagne.

La photométrie des luminaires représente une partie importante des travaux en cours et a conduit à certaines unités d'équipement spectaculaires. Les deux tunnels goniométriques sont parmi les plus longs en Europe et permettent de prendre des mesures très précises sur les projecteurs à faisceau étroit et les spots. Le photomètre à courbe polaire est de dimensions suffisantes pour permettre de prendre des mesures sur des luminaires pouvant aller jusqu'à 2,4 de long. Cet appareil enregistre les données automatiquement et les communique à un ordinateur qui calcule les paramètres de conception de l'installation à partir de ces valeurs

Des installations spéciales existent pour tester l'équipement de traitement de l'air. En plus de la salle d'isolation utilisée pour l'évaluation des propriétés acoustiques des luminaires et des plafonds, une pièce voisine du laboratoire principal renfermant une installation d'utilisation très simple la climatise ainsi que les autres bancs d'essais de la zone principale.

Ces laboratoires sont destinés à la recherche de nouvelles méthodes d'emploi de la lumière, de la couleur, du rapport entre l'éclairage des rues et les accidents, de l'éclairage des stades et des divers aspects concrets du confort visuel. Le troisième étage est consacré à un complexe pour tests complètement séparé du reste du laboratoire, homologué par la British Standards Institution et les Etablissements de Tests Nationaux européens. Les équipements d'éclairage sont soumis aux essais ici, conformément à une norme supérieure afin de satisfaire aux exigences les plus rigoureuses du Royaume-Uni et des autres pays d'Europe. Les essais de sécurité électrotechniques et thermiques, d'étanchéité à l'eau et à la poussière, et de résistance au feu de l'isolement électrique, sont effectués sur les luminaires, ensembles complets et éléments composants.

THORN exploite une des usines de ballasts les plus importantes du monde; au quatrième étage des nouveaux laboratoires, des recherches sont effectuées sur les ballasts, la transistorisation des ballasts et les unités d'éclairage d'urgence, les systèmes à mémoire et l'équipement de commande électronique de matériels et de machines.

Un laboratoire de tubes fluorescents bien situé pour accéder à l'usine de tubes d'Enfield, innove constamment dans ce domaine. Il est doté d'un spectrographe de masse, de chambres de réfrigération spéciales pour l'étude du fonctionnement à basses températures et d'un photomètre sphérique d'intégration de 3,5 m de diamètre dans lequel les tubes sont avancés sans vibration. Les recherches sur le phosphore représentent une part importante de la technologie des lampes: cette technique ainsi que le développement des lampes tunstène-halogène sont poursuivies à Enfield.

L'ÉCLAIRAGE DU MÈTRO DE STOCKHOLM 13
Bjorn Dreyfert

Au cours du récent prolongement du métro souterrain de Stockholm, les murs et les voûtes des nouvelles stations ont été décorés par des artistes, créant un effet qui en feront sûrement un pôle d'attraction touristique.

16 000 luminaires fluorescents spéciaux ont été conçus, réalisés et livrés par THORN BELYSNING au cours d'une seule année pour l'éclairage de ces stations. 600 luminaires ont pu être livrés chaque semaine à la suite d'une plannification méticuleuse et d'une étroite coopération entre le département des architectes de la Société de Transport Inter-Urbain de Stockholm et les entrepreneurs.

Les luminaires ont été réalisés en aluminium extrudé, à déflecteurs anti-éblouissants et diffuseurs en matière plastique. Ils peuvent être fixés selon sept angles différents sur des tiges de suspension et des étriers standards. Les supports de ballasts comprenaient une prise et fiche à trois broches pour un remplacement ou échange éclair, tous les luminaires étant par ailleurs conformes à la classification SEMKO S22.

Le contrat fut mené à son terme selon le programme établi; au total environ 25 colis d'appareils ont été livrés, d'une valeur d'à peu près 2 millions de couronnes et d'un poids global d'environ 160 tonnes

L'ÉCLAIRAGE INTÉRIEUR PAR PROJECTEURS 17
D. Bridgers, R. A. Kenery, K. Willis

L'acier a été produit par Sheffield depuis quatre cent ans, il n'est donc guère surprenant de voir que bien des activités de la British Steel Corporation se déroulent dans cette région. Un laminoir à barres incorporant un grand nombre d'innovations technologiques a été contruit récemment à Thrybergh près de Rotherham; il comprend huit ateliers identiques et contigus d'environ 20 m de haut, 30 m de large et 500 m de long. En l'absence de fenêtres le projet d'éclairage devait assurer une grande quantité de lumière à la fois sur le plan vertical et sur le plan horizontal.

Ce qui précède représentait un des facteurs pour le choix de la disposition des projecteurs sur une ligne continue le long de l'axe principal de chaque atelier plutôt que le recours à un système classique en hauteur; une considération plus importante encore, toutefois, était la simplicité et le coût de l'installation et de l'entretien, tous deux particulièrement réduits ainsi.

La préférence a été donnée aux lampes sodium haute pression comme sources de lumière. La lampe linéaire (SON/TD) fut montée sur des projecteurs "Haline" standards, permettant encore une baisse des frais d'installation. Ce projecteur possède un corps réflecteur mono-bloc en aluminium extrudé, assurant une performance optique précise et uniforme.

Des essais de probabilité ainsi que l'utilisation de maquettes ont démontré que deux rangées de projecteurs montés par paires dos-à-dos le long du passage central à intervalles de quatre mètres et à une hauteur de 15 m assureraient un éclairement uniforme de 350 lux, pour autant que pour chaque trois projecteurs dirigés à 26°, il y en aurait un à 4° sur le plan vertical. Des calculs minutieux furent faits afin de déterminer les niveaux d'éblouissement direct et réfléchi, calculs qui ont confirmé que le projet était bien dans le cadre des maxima suggérés par les travaux actuels de la CIE.

Finalement, des essais furent effectués sur des installations à grande échelle; ceux-ci ont indiqué que le projet s'avérait des plus satisfaisants et pour certains mieux encore qu'un agencement classique de luminaires placés à grande hauteur.

LES ESSAIS DE VIBRATION DES LAMPES AUTO 21
D. Brown et M. J. Vuliamy

Les lampes utilisées pour les automobiles sont situées aux extrémités de l'engin et sont sujettes au maximum de vibrations. Les fréquences de vibration aléatoire rencontrées dans le cas de véhicules sont de l'ordre de 20 à 400 Hz et proviennent des irrégularités de la surface de roulement et des vibrations du moteur et de la boîte de vitesses.

Jusqu'à il ya a peu de temps, chaque utilisateur d'envergure effectuait ses propres tests, souvent sous utilisation d'un équipement des plus primitifs. Une méthode de test sélective s'avère intéressante aussi bien pour l'utilisateur que pour le fabricant.

Des études routières ont été effectuées par THORN et par d'autres fabricants sur un certain nombre de véhicules et les résultats ont été enregistrés. Un équipement de test des vibrations a été développé à partir des résultats mentionnés. Trois méthodes sont en fait utilisées: le test de balayage de fréquence, le test de vibration aléatoire à bande large et le test de balayage de vibration aléatoire à bande étroite.

Des vibrateurs de force précis sont maintenant disponibles et sont capables d'effectuer des essais sur 20 à 25 ampoules à la fois, se terminant par un test d'impact ou de choc. Des tests sont en cours par les fabricants européens afin de définir des normes internationales.

LE DEVELOPPEMENT DE SOURCES LUMINEUSES EFFICACES 25
M. A. Cayless

La production de lumière à partir de l'électricité a été soumise à des recherches et améliorations constantes depuis la fabrication des premières lampes à incandescence par SWAN & EDISON. Depuis lors, l'efficacité des lampes a été constamment améliorée et aujourd'hui, on arrive à obtenir près de 100 lm/watt avec des sources de lumière blanches.

La durée de vie d'une lampe à incandescence ordinaire est limitée par le taux d'évaporation du filament et son rendement lumineux est diminué par le dépôt de tungstène sur l'ampoule elle-même. La mise en application du cycle tungstène-halogène a permis d'utiliser des pressions de gaz plus fortes et de prolonger la durée de vie de la lampe accroissant le rendement lumineux sans noircir l'ampoule. Les recherches sont poursuivies sur de nouveaux halogènes mais on ne saurait s'attendre à plus de 50 lumen/watt à partir d'une lampe à incandescence. Il est donc nécessaire de se concentrer sur les lampes à décharge.

Les tubes au mercure basse pression sont riches en rayons ultra-violets et lorsque leur paroi intérieure est enduite d'un phosphore fluorescent convenable, ils peuvent émettre toute teinte de lumière souhaitée. Une augmentation de pression de la vapeur limite l'arc et augmente la proportion de lumière visible par rapport aux rayons U.V.

Cette lumière d'une couleur inacceptable mais on peut l'améliorer par une couche de phosphore fluorescent à l'extérieur de l'ampoule.

La lampe au sodium basse pression produit énormément de lumière jaune monochrome et son rendement peut être accru par l'utilisation d'un réflecteur à infra-rouge interne. Nous savons depuis longtemps que l'augmentation de pression de la vapeur d'une lampe au sodium peut améliorer sa couleur, mais il n'était cependant pas possible de l'appliquer avant le développement des tubes à décharge adéquats. La technique de fabrication des tubes-saphir renfermant des électrodes scellés produise une lumière chaude permettant de distinguer les couleurs avec des rendements d'environ 100 lm/watt.

Une technique différente est aussi utilisée; il s'agit de l'introduction de différents métaux dans l'arc de mercure afin de "boucher" les vides de son spectre. Ceux-ci étant pour la plupart très corrosifs, ils sont introduits sous forme d'halogénures qui se désagrègent dans leurs éléments au sein du noyau surchauffé de la décharge, mais qui se reconstituent dans les sections plus froides du tube. Des lampes blanches ayant d'excellentes propriétés de reproduction de couleur sont ainsi produites, de même que des sources particulièrement compactes avec un rendement d'environ 80 lm/watt utilisées dans les projecteurs et les équipements de projection extérieurs.

La limite théorique de l'efficacité d'une lampe à lumière blanche est d'environ 200 lm/watt. Quoique la lampe au sodium basse pression puisse atteindre cette valeur, sa lumière est d'un jaune monochrome. Les lampes au sodium haute pression et les lamps aux halogénures métalliques peuvent atteindre une efficacité d'environ 100 lm/watt.

Les fabricants de lampes s'associent étroitement aux recherches effectuées par les départements de recherches gouvernementaux et des universités, dans un avenir lointain ceci pourrait donner lieu à la production de lumière par des procédés encore en laboratoire ou qui sont aujourd'hui inconnus.

In diese Ausgabe.

ZWEI UNGEWÖHNLICHE BELEUCHTUNGSANLAGEN 2

I. Maclean und R. C. Aldworth

Die Bauart der Fußböden in dem neuen Verwaltungsgebäude der Metal Box Company in Reading brachte es mit sich, daß die Decken der Räume als Kassettendecken mit großen Vertiefungen ausgebildet werden mußten. Man beschloß, diese Decken für speziell gestaltete Leuchten mit opalen Glaswannen und 80-Watt bzw. 125-Watt- Quecksilberdampflampen zu nutzen.

Da diese Leuchten ohne Berücksichtigung der Wirkung der Kassetten nicht untersucht werden durften, wurden sie in den Laboratorien von THORN LIGHTING in Enfield im Innern einer typischen Kassette besonderen physikalischen Prüfungen unterzogen, während die Glaskolben in der Frygors-Fabrik in Schweden auf Widerstand gegen thermischen Schok geprüft wurden.

Die Kassettendecke ergibt ein interessantes Muster von Licht und Schatten und belebt dadurch die Eintönigkeit großer Büroräume.

Das echte Tennisspiel, aus dem sich das heutigen Rasen Tennis entwickelt hat, wird immer noch in England gespielt. Einer der berühmtesten Hallen-Tennisplätze ist der von Hampton Court bei London, erbaut im Jahre 1530 von Heinrich VIII., der in dieser Halle selbst spielte.

Die schwarzen Wände und Fußböden der Halle, die nur von den verglasten Stäben des Fensterquerschnitts im Hauptschiff etwas Licht erhält, erforderten eine indirekte Beleuchtung, da eine direkte Beleuchtung ernsthafte Blendungsprobleme ergeben würde.

Die empfohlene Beleuchtung für ein Spiel dieser Art, das dem Squash, Badminton oder Rasen-Tennis ähnelt, beträgt 300-500 Lux, und diese Beleuchtung wird jetzt durch 36 400 W SON/TD.-Lampen in SONline Projektoren erreicht, due auf Schwellenniveau montiert sind und einen gesamten Verbrauch voln 16,35 kW aufweisen. Die Mitglieder des Royal Tennis Club in Hampton Court behaupten, daß ihre Tennishalle nicht nur die älteste, sondern auch die am besten beleuchtete Halle der Welt für das echte Tennisspiel ist.

PREISWÜRDIGKEIT 4

R. Forster

Die Preiswürdigkeit eines Beleuchtungsschemas ergibt sich aus der Kombination von zwei grundlegenden Erfordernissen. Zunächst muß über die Qualität und Quantität des Lichts entschieden werden, das unter Berücksichtigung der Produktivität und der Zufriedenheit des Personals die besten Resultate ergist; dann müssen die Lichtquellen und Leuchten gewählt werden, die diesen Erfordernissen entsprechen.

Obwohl die Beleuchtung nur einer der umgebungsbedingten Faktoren ist, die zu einer verbesserten Produktivität führen, so ist sie doch immerhin ein wichtiger Faktor. Es ist seit langem bekannt, daß die Verbesserung der Beleuchtung die Produktivität und Qualitätskontrolle erhöhen, Unfälle reduzieren, die Sicherheit erhöhen und Abwesenheit von Arbeitplatz infolfe von Überanstrengung der Augen verringern kann, abgesehen von der Verbesserung des allgemeinen Wohlbelagens. Letzten Endes kann aber nur der Verbraucher beurteilen, welche Vorteile ihm aus diesen Verbesserungen entstehehn.

Zu den Anschaffungskosten gehören die Kosten für die Leuchte, den ersten Satz Lampen und die Installation. Auch die voraussichtliche Lebensdauer der Installation muß in Betracht gezogen werden, ebenso wie die Zinsen des Kapitalaufwands. Dann sind die Kosten des jährlichen Stromverbrauchs und der Lampenerneuerung zu berücksichtigen, von denen die erstgenannten immer die höheren sind. Bei den gegenwärtigen überhöhten Kosten des Stromverbrauchs ist die Gutzung des Tageslichts anstelle von oder zusätzlich zur kunstlichen Beleuchtung in Betracht zu ziehen.

Die dritte Überlegung, die der Wartungskosten, hängt mit dem Gruppenaustausch der Lampen zusammen. Eine verschmutzte Leuchte gibt weniger Licht ab, verbraucht aber die gleiche Menge Strom als eine saubere. Das Ersetzen einer Lampe, sobald sie ausfällt, erfordert bedeutend mehr Arbeitskosten als die Anwendung eines Gruppen austauchplans. Die sich aus der Erneuerung von vorhandenen schmutzigen oder unwirksamen Ausrustungen ergebenden Einsparungen an Stromverbrauch, gefolgt von regelmäßiger Wartung und Gruppenaustauch der Lampen machen sich, was den Kapitalaufwand anbelangt, in bemerkenswert kurzer Zeit bezahlt, manchmal in der kurzen Zeit von 14-18 Monaten, d.h. 10% der durchschnittlichen Lebensdauer einer Installation. In dem Artikel werden Beispiele solcher Sparmaßnahmen genannt.

BELEUCHTUNG DER STOCKHOLMER UNTERGRUNDBAHN 13

Bjorn Dreyfert

In einer vor kurzem durchgeführten Erweiterung der Stockholmer Untergrundbahn wurden die Wände und Decken von elf neuen Stationen durch Künstler neu dekoriert. Oft wurde das ursprüngliche Gestein selbst bemalt, wodurch ein Effekt entstand, der zweifellos eine Tounsten attraktion werden wird.

Zur Beleuchtung dieser Stationen wurden von Thorn Belysning innerhalb eines Jahres 16 000 spezielle Leuchten konstruiert, gefertigt und asugeliefert. Durch eine sorgfältige Planung der Firma, und eine enge Zusammenarbeit mit der Architekturabteiling der örtlichen Stockholmer Verkehrsgesellschaft und den Installatauren konnten 600 Leuchten pro Woche an der Baustelle angeliefert werden.

Die Leuchten waren aus stranggepreßtem Aluminium und hatten blendfreie Abdeckbleche und Kunststoffwannen. Sie ließen sich in sieben verschiedenen Winkelstellungen auf Standardbügel montieren. Die Vorschattgeratege häuse waren mit dreipoligen Steckvorrichtungen versehen, so daß sie ohne Schwierigkeit ausgewechselt werden konnten. Alle Leuchten entsprachen dem SEMKO S22 Grad.

Der Auftrag wurde planmäßig ausgeführt. Alles in allem wurden 25 Ladungen von Beleuchtungskörpern angeliefert, im Werte von über 2 Millionen Kronen und mit einem Gesamtgewicht von ungefähr 160 000 kg.

NEUE LEICHTICHKEIT FUR BELEUCHTUNGS-FORSCHUNG 7

A. H. Willoughby

Die fast einmalige Stellung, die Thorn Lighting als Großhersteller sowohl von Lampen als auch von Leuchten einnimmt, versetzt die Firma in die Lage, Leuchten und Lampen gleichzeitig zu entwickeln und erforderliche Änderungen schon im Entwicklungsstadium vorzunehmen.

Die Firma unterhält zwei Forschungs- und Entwicklungsstätten - eine in Leicester, die andere in Enfield, beide in nächster Nähe der Fabriken.

Bis vor kurzem waren die Forschungsstätten in Enfield unzulänglich teilweise im alten Atlas Labor, teilweise über dem ganzen Werksgelände verteilt untergebracht. Das neue, zweckentsprechend gebaute Laboratorium hat Raum für alle Tätigkeiten, die nachfolgend näher beschrieben werden.

Die Entwicklungsstätte für Beleuchtungskörper ist vor allem dazu bestimmt, dafür zu sorgen, daß das breite Produktionsprogramm der Thorn Lighting - Leuchten den behördlichen Vorschriften entspricht, die in verschiedenen Ländern außerhalb Großbritanniens bestehen. Die Fotometrie der Leuchten ist ein wichtiger Teil der dort ausgeführten Arbeiten, die einige wirklich imposante Geräte hervorgebracht haben. Die beiden Goniometertunnel gehören zu den längsten in Europa. Sie ermöglichen außerordentlich präzise Messungen von Flutbeleuchtungskörpern und Strahlern mit schmalen Strahlkegeln. Das Polarkurven-Fotometer ist groß genug, um bis zu 2,4 m lange Leuchten messen zu können. Die Angaben werden automatisch registriert und in einen Computer gespeist, der dann die Konstruktionsdaten der Einrichtung errechnet.

Für Klimaleuchten sind besondere Einrichtungen vorhanden. Außer dem zur Beurteilung der akustischen Eigenschaften von Leuchten und Decken benutzten Isolierraum gibt es, getrennt vom Hauptlabor noch einen Raum, in welchem sich eine hochgradig flexible Klima-Anlage befindet, die das Labor und andere Teststände im Hauptraum versorgt.

Diese Stätten dienen der Erforschung neuer Wege der Lichtausnutzung in Verbindung mit Farben, der Beziehung zwischen Straßenbeleuchtung und Unfällen, der Beleuchtung von Stadien sowie der verschiedenen Aspekte visuellen Komforts. Im dritten Stock befindet sich ein Testhaus, das von den anderen Laboratoriumsabteilungen vollkommen abgetrennt ist. Es ist von der British Standard Institution und von den europäischen nationalen Testhäusern anerkannt. Hier werden die Leuchten nach einem Urmuster geprüft, um zu gewährleisten, daß sie den rigorosen Vorschriften der englischen und europäischen Behörden entsprechen. Die fertigen Leuchten werden ebenso wie ihre Bestandteile Prüfungen auf elektrische und thermische Sicherheit, auf Wasser- und Staubbeständigkeit sowie auf elektrische Isolation gegen Entflammbarkeit unterzogen.

Thorn betreibt eine der größten Fabriken der Welt für Vorschaltgeräte. Im vierten Stockwerk des neuen Laborgebäudes werden Forschungsarbeiten an Steuergeräten, transistorisierten Vorschaltgeräten, Notbeleuchtungseinrichtungen, Speichersystemen sowie elektronischen Steuergeräten für Maschinen vorgenommen.

Ein Leuchtröhrenlabor, von dem aus man einen bequemen Zugang zur Röhrenfabrik in Enfield hat, bringt immer noch Neuerungen auf diesem Gebiete hervor. Es ist mit einem Massenspektrometer, besonderen Kühlräumen zur Untersuchung von Geräten bei Tieftemperaturbetrieb sowie einem 3,5 m ø sphärischem Integralfotometer ausgerüstet, in den von einem schüttelfreien Motor Röhren eingespeist werden. Die Phosphorforschung bildet einen wichtigen Bestandteil der Lampentechnologie. Diese Forschungsarbeiten sowie die Entwicklung von Halogenlampen werden ebenfalls in Enfield ausgeführt.

FLUTLICHTBELEUCHTUNG IM INNENRAUM 17

D. Bridgers, R. A. Kenery und K. Willis

Seit 400 Jahren wird in Sheffield Stahl produziert. Es ist daher kein Wunder, daß sich hier viele der Betriebe der British Steel Corporation befinden. Kürzlich wurde in Thrybergh bei Rotherham ein neues Stabwalzwerk errichtet, das viele neue technische Neuerungen aufzuweisen hat. Es besteht aus 8 gleichartigen, nebeneinander aufgebauten Hallen, die alle etwa 20m hoch, 30m breit und 500m lang sind. Da keinerlei Fenster vorhanden sind, mußte im Beleichtungsplan viel Licht vorgesehen werden, und zwar sowohl auf der vertikalen als auch auf der horizontalen Ebene.

Dies war einer der Faktoren, die ausschlaggebend waren für den Entschluß, anstelle des üblichen Hochhallensystems entlang der Hauptachse einer jeden Halle Flutlichkörper in einer laufenden Reihe anzubringen. Noch wichtiger war die Überlegung, daß auf diese Weise Einsparungen an Installations- und Wartungskosten erzeilt werden konnten, die beide durch diese Methode erleichtert werden.

Natriumdampf-Hochdrucklampen wurden als Lichtquelle gewählt, weil sie sowohl eine hohe Lichtausbeute als auch eine gute Farbwiedergabe haben. Die doppelseitige Linearlampe (SON.TD) wurde in standardmäßigen "Haline" Strahlern verwendet — eine weitere Einsparung an Installierungskosten. Diese Strahlern haben einteilige Reflektoren aus stranggepreßtem Aluminium und gewähren eine genaue optische Leistung.

Durchführbarkeitsversuche und der praktische Einsatz von Modellen haben erwiesen, daß zwei Reihen von Flutlichtbeleuchtungskörpern, in Abständen von vier Meter und in einer Höhe von 15 m Rücken an Rücken paarweise angeordnet, eine gleichmäßige Beleuchtungsstärke von 350 Lux ergeben, wenn für jede auf einen Erhöhungswinkel von 26° eingestellte drei Flutlichtkörper einer angebracht ist, der von der Vertikalen auf 4° eingestellt ist. Sorgfältige Berechnungen zur Bestimmung der direkten und reflektierten Blendung ergaben, daß dieses Schema die von der CIE vorgeschlagenen Höchstwerte in keiner Weise überschreitet.

Zum Schluß wurden komplette Versuchseinrichtungen installiert, die zeigten, daß das Schema im höchsten Grade zufriedenstellend, und in mancher Hinsicht besser als die übliche Anordnung von Hochhallenleuchten ist.

VIBRATIONSTESTS FÜR AUTOLAMPEN 21

D. Brown und M. J. Villiamy

Die zerbrechlichsten Teile eines Kraftfahrzeugs sind wahrscheinlich die Autolampen. Die Schwingzahlen von Kraftfahrzeugen liegen im Bereich von 20 bis 400 Hz und sind das Ergebnis von Unregelmäßigkeiten der Straßenoberfläche und der Vibration von Motor und Getriebe.

Thorn und andere Hersteller führten mit einer Reihe von Fahrzeugen Straßenprüfungen durch und zeichneten die Ergebnisse auf. Aufgrund dieser Vibratronstests wurden dann entsprechende Geräte entwickelt. Zur Zeit finden drei verschiedene Methoden Anwendung: der Frequenzwobbeltest, der Breitband-Stichprobentest und der Vibrationswobbeltest mit Schmalband.

Es gibt jetzt genau arbeitende und kraftvolle Vibratoren, mit denen sich 20 bis 25 Lampen zur gleichen Zeit testen lassen. Abschließend findet ein Schlagtest statt, Europäische Hersteller tauschten untereinander die Prüfungen aus, um eine internationale Norm aufstellen zu können.

Die Tests haben bereits dazu geführt, daß gewisse Lampendesigns geändert wurden, um eine größere Zuverlässigkeit beim Fahren zu erzielen, was offensichtlich im Interesse sowohl des Verbrauchers als auch des Herstellern liegt.

DIE ENTWICKLUNG RATIONELLER LICHTQUELLEN 25

M. A. Cayless

Seit Swan und Edison im Herbst 1878 und im Frühling 1879, die Nutzdauer der gewöhnlichen Glühlampe ist durch die Verdampfungsgeschwindigkeit des Wendels beschränkt und ihre Lichtausbeute wird durch die Ablagerung von Wolfram auf den Kolben vermindert. Die Anwendung des Halogenzyklus macht höhere Gasdrücke möglich, verlängert dadurch die Lebensdauer der Lampe und läßt höhere Wendeltemperaturen zu. Die Lichtausbeute wurde somit erhöht, ohne den Kolben zu schwärzen. Die Erforschung neuer Halogenide wird fortgesetzt, aber von einer Glühlampe können wir nicht mehr als 50 Lumen/Watt erwarten.

Bis vor ungefähr 10 Jahren enthielten die meisten Entladungslampen entweder Quecksilberdampf oder Natriumdampf. Quecksilberdampf-Nierderdruckröhren sind reich an UV-Strahlung, und wenn sie mit einem geeigneten Phosphorleuchtstoff innen beschichtet sind, können sie ein Licht jeder gewünschten Färbung erzeugen. Durch Erhöhung des Dampfdrucks wird eine Beschränkung des Bogens bewirkt, mit dem Resultat, daß der Anteil sichtbaren Lichts für die UV-Strahlung erhöht wird. Die Lichtfarbe ist nicht akzeptable, aber diesem Umstand läßt sich leicht abhelfen, indem man den äußeren Kolben mit einem geeigneten Leuchtstoffphosphor bestreicht. Auf diese Weise lassen sich Wirkungsgrade erzielen, die denen der De Luxe Leuchtstofflampen fast gleichkommen.

Eine Natriumdampf-Niederdrucklampe ist ein sehr guter Erzeuger von einfarbigem gelben Licht. Theoretisch steht seit langem fest, daß die Farbe des Lichts einer Natriumdampflampe durch Erhöhung des Dampfdrucks verbessert werden kann, aber eine praktische Durchführung dieses Prinzips wurde erst möglich, als geeignete Entladungsröhren entwickelt worden waren. Die Technik der Erzeugung von Saphirröhren und des Einschmelzens der Elektroden, stellte hohe Anforderungen an Geschicklichkeit und Fachwissen der Lampenhersteller. Aber heute werden solche Lampen weitgehend verwendet. Sie geben ein warmes Licht ab, bei dem bei Wirkungsgraden bis zu 100 lm/Watt Farben klar erkennbar sind.

Eine andere Möglichkeit besteht darin, in den Quecksilberbogen andere Metalle einzuführen, die die Lücken in seinem Spektrum ausfüllen. Da die meisten dieser Metalle hochgradig korrosiv sind, sind diese Halogenide, die in der Heißphase der Entladung in ihre Elemente zerfallen, sich aber in den kühleren Teilen der Röhre wieder verbinden. So lassen sich wirklich ausgezeichnete Farbwiedergabeeigenschaften in weißen Lampen erzeugen, ebenso wie außerordentlich kompakte Lichtquellen mit Wirkungsgraden von ungefähr 80 lm/Watt für Projektoren und Flutlicht-Außenbeleuchtung.

Die theoretische Begrenzung des Wirkungsgrads einer ein weißes Licht abgebenden Lampe liegt ungefähr bei 200 lm/Watt. Die Natriumdampf-Niederdrucklampe erreicht zwar diese Zahl, aber das Licht ist ein einfarbiges Gelb. Da Natriumdampf-Hochdrucklampen und Halogen-Metalldampflampen Wirkungsgrade von ungefähr 100 lm/Watt erreichen, bestehen Möglichkeiten für zukünftige Entwicklungen.

Die Lampenhersteller arbeiten eng mit den Forschungsabteilungen amtlicher Stellen und der Universitäten zusammen. In späterer Zeit kann dies zu einer Erzeugung von Licht durch Verfahren führen, die sich heute noch im Versuchsstadium befinden oder überhaupt noch nicht bekannt sind.

Nel questa edizione.

DUE INSOLITI IMPIANTI DI ILLUMINAZIONE 2
I. Maclean e R. C. Aldworth

Per la costruzione dei pavimenti dei nuovi uffici della Metal Box Company, a Reading, è stato necessario ricorrere a controsoffitti profondi. Venne deciso di utilizzarli per sistemarvi speciali apparecchi con lampade a vapori di mercurio di 85 o 125 W, in globi di vetro opalino.

Essendo parte del integrante cassettone che li ospitava, vennero sottoposti ad'analisi gli aperecchi fotometrica e fisica, in un cassettone tipo, presso i laboratori della Thorn Lighting di Enfield; a loro volta, i globi vennero sottoposti a prove di resistenza allo shock tèrmico, presso lo stabilimento Frygors, nella Svezia.

I controsoffiti creano un interessante effetto di luce ed ombra che allevia la monotonia tipica dei grandi locali adibiti ad ufficio.

Il tennis reale dal quale, a suo tempo, derivò il tennis su prato, è tuttóra uno sport praticato in Gran Bretagna. Una tra le più famose 'corti' è quella di Hampton Court, nei pressi di Londra, costruita da Enrico VIII nel 1530, che vi praticò lo sport personalmente.

Le nere pareti ed il pavimento del cortile, vivacizzati soltanto dal biancore delle barre dei lanternini, debbono venir illuminati indirettamente poichè un'illuminazione diretta creerebbe seri problemi di abbagliamento. L'impianto esistente, costituito da una serie di lampade a vapore di mercurio ad alogeno, forniva complessivamente 80 lux, con un carico di 15 kW.

Per uno sport di questo tipo – analogo allo squash, al badminton o al tennis su prato – occorre un illuminamento di 300-500 lux, fornito attualmente dalle 36 lampade SON TD 400W, in proiettori SONline situati a livello dei davanzali. Il carico totale è di 16 35 kW.

DANARO BEN SPESO 4
R. Forster

Per risolvere il problema dell'illuminazione di un ambiente occorre valutare due requisiti fondamentali – ossia, determinare la qualità e l'intensità dell'illuminazione atte a stimolare la produttività e il comfort del personale indi selezionare la sorgente luminosa specificamente adatta per questo scopo.

Quantunque contribuisca solo marginalmente all'incremento della produttività, tuttavia una buona illuminazione riveste specifica importanza poichè agevola il controllo della qualità, riduce gli infortuni, migliora la sicurezza sul lavoro, combatte l'assenteismo sovente promosso dall'affaticamento degli occhi e rallegra l'atmosfera. Malgrado tanto, solo il proprietario di stabilimento può valutarte gli effettivi vantaggi apportati dai suddetti miglioramenti.

Il costo complessivo dell'installazione è costituito dal costo d'acquisto e dai costi d'esercizio e di manutenzione, nel corso dell'anno.

Il primo è a sua volta costituito dal costo delle plafoniere, della prima serie di lampade e dell'installazione vera e propria. Occorre in pari tempo considerare la durata dell'impianto e gli interessi applicati sul capitale investito. Successivamente, si debbono calcolare i costi annui dell'energia assorbita e delle sostituzioni, dei quali il primo è normalmente il più elevato. Tenuto conto dei forti aumenti verificatisi nel costo dell'energia, occorrerà utilizzare la luce solare per quanto possibile, al posto o come supplemento alla luce artificiale.

La terza considerazione, ossia, la manutenzione, è vincolata alla sostituzione periodica delle lampade. Una plafoniera sporca emette meno luce pur consumando esattamente lo stesso quantitativo di energia di una plafoniera pulita; la sostituzione individuale delle lampade difettose incide maggiormente sui costi che la sostituzione a programma. I risparmi di energia realizzabili mediante la regolare sostituzione degli apparecchi sporchi o difettosi, la manutenzione pianificata e il ricambio delle lampade a programma permettono di recuperare sollecitamente il capitale investito – tale periodo a volte consiste di soli 14-18 mesi, ossia, il 10% della durata media di una installazione. L'articolo fornisce una serie di esempi.

FACILITE NUOVE DELLA RICERCA NEL SETTORE DELL'ILLUMINAZIONE 7
A. H. Willoughby

La posizione virtualmente esclusiva della Thorn Lighting, come costruttrice di primaria importanza di lampade ed apparechi per l'illuminazione, agevola l'apporto dei perfezionamenti tanto alle lampade quanto agli apparecchi contemporaneamente.

La società possiede due laboratori di ricerca e progettazione, a Leicester e an Enfield, ciascuno dei quali è ad immediato contatto con gli attigui stabilimenti di lavorazione.

Fino a poco tempo addietro i laboratori di Enfield erano situati nei vecchi Laboratori Atlas oppure sparsi nello stabilimento; il nuovo laboratorio, invece, ospiterà tutte le attività descritte nel presente articolo.

Nei laboratori per la progettazione degli apparecchi, il personale accerterà che la serie di apparecchi Thorn Lighting risponda alle prescrizioni legali vigenti in vari paesi fuori della Gran Bretagna. Un'importante parte del lavoro è la fotometratura degli apparecchi, per questo compito si usano apparecchiature letteralmente spettacolari. Le due gallerie a goniometro sono tra le più lunghe d'Europa e permettono di ricavare misurazioni di alta precisione sui projettori a fascio stretto e puntiforme. Il fotometro a curva polare è di dimensioni sufficienti per rilievi su apparecchi della lunghezza fino a 2,4 metri. I dati vengono registrati automaticamente indi passati al calcolatore che ne deriva i criteri di progrettazione dell'impianto.

Oltre alla camera insonorizzata adibita a stabilire le proprietà acustiche degli apparecchi di i'luminazione dei soffitti, esiste un'apposita sala, fuori del laboratorio principale, in cui è situato un impianto di condizionamento dell'aria altamente versatile, che serve detta sala e altri locali che ospitano le apparecchiature di prova.

In questi laboratori si svolge la ricerca di nuovi metodi per ottenere luce colorata, si studia il rapporto esistente tra l'illuminazione stradale e gli incidenti, si risolvono i problemi dell'illuminazione degli stadi sportivi e si trattano vari aspetti soggettivi del comfort visivo. Al terzo piano è situata la sala prove, separata dal resto del laboratorio; essa è ufficialmente riconosciuta dal British Standards Institution e dalla European National Test Houses. Qui, gli apparecchi di illuminazione vengono verificati in base alle norme relative onde accertarne la conformità alle più severe prescrizioni vigenti in Gran Bretagna ed in altri paesi d'Europa. Qui vengono svolte prove sulla sicurezza elettrica e termica, sull'impermeabilità all'acqua ed alla polvere, sull'infiammabilità, sull'isolamento elettrico su plafoniere complete e sui rispettivi componenti.

La Thorn è una della più importanti costruttrici di reattori di oggigiorno; al quarto piano si svolge la ricerca sugli alimentatori, sui reattori transistorizzati, sulle unità di illuminazione d'emergenza, sui sisterni a memoria per teatri e studi cinematografici e sulle apparecchiature elettroniche che controllano il macchinario.

Il laboratorio per le lampade a fluorescenza, attiguo allo stabilimento di lavorazione di Enfield, apporta continue innovazioni in questo settore. Il laboratorio possiede uno spettrometro di massa, speciali camere refrigerate per l'analisi del funzionamento a basse temperature ed un fotometric sferico del diametro di 3,5m, nel quale vengono inserite le lampade mediante un motore funzionante senza la minima scossa La ricerca sul fosforo è un importante aspetto di questa branca della tecnologia; tale ricerca e gli studi di miglioramento delle lampade ad alogeno si svolgono regolarmente ad Enfield.

ILLUMINAZIONE DELLA METROPOLITANA DI STOCCOLMA 13
Bjorn Dreyfert

Le pareti e le volte di undici nuove stazioni, parte del recente ampliamento della metropolitana di Stoccolma, sono state decorate dan un gruppo di artisti che, creando un effetto destinato ad esercitate una forte attrazione sui turisti.

Per illuminare le stazoni sono state usate 16.000 speciali plafoniere fluorescenti, progettate, costruite e consegnate, nel giro di un anno, dalla Thorn Belysning. La precisa programmazione da parte della ditta e la stretta collaborazione svolta con gli architetti della Local Communicators Company di Stoccolma e con le varie imprese hanno permesso di consegnare con regolarità, un contingente di 600 plafoniere settimanali ai cantieri.

Le plafoniere, di alluminio estruso, incorporano riflettori antiabbagliamento e diffusion di plastica. Esse sono state installate con differente angolazione mediante convenzionali asti di sospensione e staffe. Il corpo base incorpora una morsettiara tripolare con spina, per semplificare la sostituzione; le plafoniere sono conformi alle norme SEMKO S22.

Il contratto è stato rispettato con perfetta regolarità; complessivamente, sono state effettuate 25 forniture, del peso globale di 160.000 chili, per un valore di circa 2 milioni di corone.

L'ILLUMINAZIONE DEGLI INTERNI 17
D. Bridgers, R. A. Kenery e K. Willis

Sheffield ha prodotto acciaio per beri 400 anni per cui non ci sorprende constatare che, gran parte delle attività della British Steel Corporation, si svolge esattamente in questa regione. Recentemente, a Thrybergh, nei pressi di Rotherham, è stato costruito un nuovo laminatoio che incorpora molteplici innovazioni tecnologiche; esso consiste in otto reparti identici, collegati l'uno all'altro, che misurano 20 metri d'altezza, 30 metri di larghezza e 500 metri di lunghezza. Detti reparti sono sprovvisti di finestre per cui è stato indispensabile provvedere ad una potente illuminazione sui piani verticale ed orizzontale.

Venne pertanto prescelto un sistema di illuminazione mediante una serie continua di proiettori sistemati lungo l'asse principale di ciascun reparto, anziché ricorrere alla convenzionale illuminazione dall'alto; tale criterio ha semplificato l'installazione, riducendo in pari tempo i costi dell'installazione stessa e della manutenzione.

Per l'illuminazione vennero scelte lampade a vapori di sodio ad alta pressione, soddisfacente. Le lampade lineari (SON. TD) vennero sistemate nei proiettori stagni 'Haline' per ridurre ulteriormente i costi d'installazione. Il proiettore è dotato di un riflettore in un blocco unico, di alluminio estruso, di elevate caratteristiche ottiche.

Le prove con l'uso di modelli, hanno indicato che due file di proiettori sistemati a coppie schiena contro schiena, sulla passerella centrale, con 4 metri di intervallo all'altezza di 15 metri, possono fornire un illuminamento di 350 lux, orientando tre proiettori ad un angolo di elevazione di 26° ed un quarto proiettore a 4°, rispetto il verticale.

Vennero parimenti effettuati calcoli atti a determinare il livello dell'abbagliamento diretto e riflesso i quali hanno permesso di accertare che, sotto questo aspetto, il progetto rientra opportunamente nei limiti suggeriti attualmente dalla CIE.

Per ultimo, vennero compiute prove d'installazione a carattere completo le quali indicarono che la soluzione era perfettamente soddisfacente e, sotto alcuni aspetti, spiccatamente migliore dei metodi convenzionali adottati per l'illuminazione dei reparti.

PROVA DI VIBRAZIONE DELLE LAMPADE PER AUTOVETTURE 21
D. Brown e M. J. Vuliany

Le lampade, probabilmente i componenti più fragili delle autovetture, sono situate in posizioni in cui vengono assoggettate alle vibrazioni più intense. Le frequenze delle vibrazioni casuali riscontrate sulla autovetture variano tra 20 e 400 Hz e sono dovute all'irregolarità del manto stradale ed alle vibrazioni del motore e del cambio.

Fino a poco tempo addietro le grandi società costruttrici hanno svolto prove in proprio usando, sovente, apparecchiature piuttosto primitive. Il filamento delle lampade a 24V è meno resistente di quello delle lampade a 12V però, poichè sulla maggioranza dei grossi veicoli vengono impiegate le lampade a tensione più alta, un metodo di analisi selettiva serve gli interessi dell'utente e del costruttore.

La Thorn ed altri costruttori hanno svolto un ciclo di studi contemplanti le prove su strada, su veicoli di vario tipo; i risultati vennero debitamente trascritti. In tal modo è stato possibile realizzare apparecchiature di prova più attendibili. I metodi impiegati sono tre: la prova delle frequenze, la prova delle vibrazioni casuali a banda larga e la prova delle vibrazioni casuali a banda stretta.

Attualmente, vengono impiegati vibratori potenti e precisi che possono controllare da venti a venticinque lampade per volta; per ultimo, ha luogo la prova d'urto con attrezzature che simulano lo sbattere delle porte, dello sportello del vano bagagli, ecc. Si stanno in pari tempo svolgendo prove da altri costruttori europei destinate alla formulazione di normi internazionali.

Le prove si sono già concretizzate in modifiche apportate alla configurazionne della lampada che assicurano maggior affidamento in servizio; quanto detto ovviamente riflette gli interessi dell'utente e del costruttore.

LA PROGETTAZIONE DI EFFICIENTI SORGENTI DI ILLUMINAZIONE 25
M. A. Cayless

La produzione economica della luce, mediante l'elettricité, è stata ogetto di un approfondito ciclo di studi e di ricerche, che risale all'epoca in cui Swan ed Edison realizzarono la prima lampada ad incandescenza nell'autunno del 1878 e nella primavera del 1879, rispettivamente. Da tale epoca, l'efficienza delle lampade è migliorata costantemente ed oggigiorno le lampade a vapore di sodio a bassa pressione producono 170 lm/watt di luce gialla monocromatica, mentre si possono raggiungere praticamente 100 lm/watt con luce più bianca.

La durata di una normale lampada a filamento è limitata dal tasso di sublimazione del filamento stesso mentre l'emissione luminosa diminuisce con la progressiva deposizione del tungsteno sul bulbo. L'alogeno crea pressioni del gas più elevate prolungando la durata della lampada e permettendo che la temperatura più alta del filamento incrementi l'intensità luminosa, senza annerire la lampada. Per quanto proseguano le ricerche sui nuovi alogeni, non sarebbe realistico aspettarci più di 50 lumen per watt, con le lampade a filamento. Occorre pertanto orientare le ricerche verso le lampade a scarica.

Fino a dieci anni fà, la maggioranza delle lampade a scarica conteneva vapore di mercurio o di sodio. Le lampade vapore di mercurio, a bassa pressione, emettono radiazioni ultraviolette per cui, se vengono revistite all'interno con un opportuno fosforo fluorescente, potranno produrre luce in qualsiasi colore. Aumentando la pressione del vapore si restringe l'arco aumentando in pari tempo la proporzione della luce visibile rispetto alle radiazioni U.V. La luce ha un colore inaccettabile però può venire corretta applicando sul bulbo esterno della lampada una patina di fosforo fluorescente. In tal modo si può raggiungere una efficienza praticamente uguale a quella delle lampade a fluorescenza tipo de luxe.

Le lampade a vapore di sodio, a bassa pressione, sono efficienti sorgenti di luce galla monocromatica, detta efficienza, può venire ulteriormente incrementata usando un riflettore interno agli infrarossi. Già da tempo è stato constatato che se si aumenta la pressione del vapore di una lampada al sodio si migliora il colore della luce però non è stato possibile porre in pratica tale constatazione fino a quando non vennero realizzati bruciatori adatti. Costruire bruciatori di quarzo incorporandovi e sigillandovi gli elettrodi è stata, a suo tempo, una severa prova della perfezione tecnica dei più specializzati stabilimenti operanti in questo settore; dette lampade vengono oggi usate assai diffusamente e producono una lace calda sotto cui i colori possono venire chiaramente distinti con una efficienza di circa 100 lm/watt.

Una variente consiste nell'introdurre altri metalli nell'arco del vapore di mercurio, per completate lo spettro. Poichè la maggioranza di tali metalli è altamente corrosiva, l'introduzione avviene sotto forma di alogenuri che si dissociano nei rispettivi elementi, nel centro caldo della scarica, però tornano a combinarsi nelle parti meno calde del bruciatore. In tal modo è possibile produrre lampade a luce bianca con eccellente resa cromatica oppure sorgenti di luce altamente compatte con efficienza luminosa di circa 80 lm/watt, per proiettori e per illuminazione di esterni.

Il limite teorico dell'efficienza di una lampada a luce bianca è di circa 200 lm/watt. La lampada a vapore di sodio, a bassa pressione, può raggiungere il suddetto valore però la luce è gialla monocromatica. Le lampade a vapore di sodio, ad alta pressione e le lampade con alogenuri metallici possono raggiungere 100 lm/watt per cui denotano ancora prospettive di futuro miglioramento – forse, utilizzando nuovi tipi di composti volatili.

I costrutton collaborano alle ricerche svolte dagli appositi dipartimenti governativi e dalle iniversità – nel futuro, probabilmente, la luce verrà prodotta mediante procedimenti che, al momento, sono ancora oggetto di studio o sono ancora del tutto sconosciuti.

En esta edición.

DOS INSTALACIONES DE ALUMBRADO FUERA DE LO COMÚN 2
I. MacLean y R. C. Aldworth

En la construcción de los pisos de las oficinas de Metal Box Company en Reading se emplearon techos de artesonado profundo. Se decidió utilizar estos techos para alojar unas luminarias especialmente diseñadas, con lámparas fluorescentes de mercurio de 85 o 125W en globos de cristal opalescente.

Al no poder considerarse por separado del artesón donde van instaladas, se hicieron pruebas fotométricas y físicas de estas luminarias en el interior de un artesón típico en los laboratorios de Thorn Lighting en Enfield, mientras que las bombillas de vidrio recibieron pruebas de resistencia al choque térmico en la fábrica de Frygors en Suecia

El empleo del techo artesonado da una forma de luz y sombra muy interesante y alivia la monotonía de los grandes espacios de las oficinas.

El tenis real, que es el juego precursor del tenis sobre hierba, continúa jugándose en Gran Bretaña. Una de las más famosas canchas a cubierto es la de Hampton Court, cerca de Londres, que fue construída en 1530 por orden de Henry VIII y donde jugaba este famoso monarca.

En el piso y paredes negras de la cancha, aliviados solamente por las baquetillas blancas en las ventanillas superiores, se precisa un alumbrado indirecto, ya que el alumbrado directo presentaría graves problemas de deslumbramiento

La iluminancia recomendada para un deporte de esta naturaleza (similar al frontón americano, badminton o tenis sobre hierba) es de 300 a 500 lux y se provee esto ahora mediante 36 lámparas de sodio de alta presión, tipo SON. TD de 400W en unos proyectores SONline montados al nivel de la repisa, con una carga total de 16,35kW.

BUENA ECONOMÍA 4
R. Forster

El máximo provecho en un sistema de alumbrado resulta de la combinación de dos requerimientos básicos: decidir la calidad y cantidad de luz para obtener el máximo beneficio en cuanto a la productividad y satisfacción del personal y seleccionar y aplicar la mejor fuente de luz y luminaria para proveerla.

Si bien el alumbrado es sólo uno los factores ambientales que resultan en una productividad mejorada, resulta muy importante. Ya se ha establecido que las mejoras en el alumbrado pueden aumentar la productividad y el control de calidad, reducir el número de accidentes, mejorar la seguridad, reducir las ausencias debido al cansancio ocular y mejorar el ambiente, pero en el análisis final solamente el usuario puede evaluar el beneficio que obtiene de estas mejoras.

El costo total de una instalación de alumbrado está compuesto por el desembolso de capital, costo anual de explotación y costo anual del mantenimiento.

En el desembolso inicial se incluye el costo de las luminarias, el primer juego de lámparas y la instalación. Hay que tener también en cuenta la duración prevista de la instalación y los intereses del capital desembolsado. A continuación viene el costo del consumo anual de energía y la renovación de lámparas, siendo el primero de éstos siempre el mayor. Con el costo actual de la energía eléctrica, merece la pena considerar el empleo de la luz del día en lugar del alumbrado artificial o como adición al mismo.

La tercera consideración, la del mantenimiento, está relacionada con la renovación colectiva de las lámparas. Una luminaria sucia produce menos luz pero consume la misma corriente que una limpia. El renovar las lámparas según van fallando cuesta mucho más en mano de obra que el disponer de un sistema de renovación colectiva. El ahorro en consumo de corriente que resulta de cambiar los equipos sucios o poco eficientes, seguido de un mantenimiento regular y de la renovación colectiva de las lámparas, podrá reembolsar el desembolso de capital en un tiempo sorprendentemente corto, algunas veces de 14 a 18 meses, que supone el 10% de la duración promedio de una instalación. Se completa este artículo dando ejemplos de tales economías en instalaciones diversas.

NUEVOS LABORATORIOS PARA LA INVESTIGACION EN EL ALUMBRADO 7
A. H. Willoughby

La posición singular de Thorn Lighting, como fabricante de lámparas y equipos de alumbrado, permite que se puedan desarrollar las fuentes de luz al mismo tiempo que las luminarias y que puedan hacerse los ajustes pertinentes durante el desarrollo.

La Compañía tiene dos laboratorios de Investigación y Desarrollo, ubicados en las ciudades de Leicester y Enfield, cada uno de ellos próximo a sus fábricas circundantes.

Hasta hace poco tiempo, los laboratorios de Enfield estaban alojados en los antiguos Laboratorios Atlas o esparcidos en el área de la fábrica. El nuevo laboratorio que se ha construído ex profeso contiene todas las actividades que se describen en este artículo.

Los Laboratorios para Desarrollo de Luminarias han sido diseñados para garantizar que la amplia gama de accesorios de Thorn Lighting cumpla con los requisitos obligatorios de varios países fuera de Gran Bretaña. Una parte importante de este trabajo es la fotometría de luminarias, habiendo resultado en unos equipos espectaculares. Los dos túneles goniométricos se hallan entre los más largos de Europa y permiten realizar mediciones muy exactas en lámparas de luz concentrada y proyectores de haz estrecho. El fotómetro de curva polar es lo suficientemente grande para poder efectuar mediciones en luminarios de hasta 2,4m. de largo. Registra automaticamente los datos y los pasa a un ordenador electrónico, el cual calcula a partir de los mismos los datos de diseño de una instalación.

Existen facilidades especiales para pruebas de luminarias que conduzcan aire acondicionado. Además de la sala aislada que se emplea para determinar las propiedades acústicas de techos y luminarias, se halla instalada en una sala anexa al laboratorio principal una planta de aire acondicionado extremamente flexible que sirve a todas las instalaciones de pruebas en el área principal.

Estos laboratorios se ocupan de la investigación de nuevas formas de utilizar la luz, de la relación existente entre el alumbrado publico y los accidentes, del alumbrado de estadios y de los varios aspectos subjetivos del bienestar visual. En el tercer piso hay una sala de pruebas que está aislada del resto del laboratorio y que es aprobada por la Institución de Normas Británicas y por los Entidades de Pruebas de los Países Europeos. Se prueban aquí los equipos de alumbrado a una norma patrón para satisfacer los requisitos más estrictos, tanto del Reino Unido como de otros países extranjeros. Las pruebas de seguridad eléctrica y térmica, estanqueidad al agua y polvo y de inflamabilidad del aislamiento eléctrico, se hacen en luminarias completas y en sus componentes.

Thorne tiene una de las mayores fábricas de reactancias en el mundo. En el cuarto piso de los nuevos laboratorios se lleva a cabo un programa de investigación en dispositivos de control, balastros transistorizados, unidades de alumbrado de emergencia y sistemas de memoria para estudios de televisión y escenarios, así como equipos electrónicos de control para maquinaria.

Un laboratorio de tubos fluorescentes, que está convenientemente situado para facilitar el acceso a la fábrica de tubos fluorescentes de Enfield, continúa produciendo innovaciones en este campo. Este laboratorio está equipado con un espectrómetro de masas, cámaras especiales de refrigeración para investigar la operación a bajas temperaturas y un fotómetro integrador esférico de 3,5m. de diámetro, al cual se introducen los tubos por un motor a prueba de sacudidas. La investigación de los fósforos fluorescentes es un campo importante en la tecnología de la lámparas que también se lleva a cabo en Enfield, junto con el desarrollo de lámparas de tungsteno halogen (cuarzo-iodo)

ALUMBRADO DEL "METRO" DE ESTOCOLMO 13
Bjorn Dreyfert

En una reciente ampliación del Ferrocarril Subterráneo de Estocolmo, las paredes y techos han sido decorados por artistas en once nuevas estaciones, en efecto que sin duda pasará a ser una atracción turística.

Para alumbrar estas estaciones, Thorn Belysning ha diseñado, fabricado y entregado 16.000 luminarias fluorescentes especiales en un año. Como resultado de la cuidadosa planificación por parte de la Compañía y de la estrecha cooperación con el Departamento de Arquitectura de la Compañía de Comunicaciones Locales de Estocolmo y con los contratistas, se entregaron en obra 600 luminarias por semana.

Las luminarias se hicieron de aluminio extruído, con deflectores antideslumbramiento y difusores de plástico. Estas luminarias pueden montarse a siete ángulos diferentes con varillas y estribos de suspensión normalizados. En las bandejas de dispositivos llevan un enchufe macho y hembra de tres clavijas para facilitar los recambios y todas las luminarias cumplen con las especificaciones SEMKO clase S22.

El contrato se conluyó conforme a lo planeado. En total, se entregaron unas 25 cargas de luminarias por un valor de unos 2 millones de coronas suecas y con un peso total de unos 16.000kg.

EL ALUMBRADO INTENSIVO SE PASA AL INTERIOR 17
D. Bridgers, R. A. Kenery y K. Willis

Se ha estado produciendo hierro en la cuidad de Sheffield durante 400 años y no sorprende por tanto hallar que muchas de las actividades de la British Steel Corporation se llevan a cabo en esta zona. Se ha construído recientemente en Thryberg, cerca de Rotherham, un nuevo tren de redondos con varias innovaciones técnicas, el cual consta de 8 naves idénticas, cada una de 20 m. de altura x 30 m. de anchura y 500 m. de longitud, unidas por los costados. No existen ventana y por lo tanto el sistema de alumbrado tenía que proveer una buena cantidad de luz en los planos horizontal y vertical.

Este fue uno de los factores en la elección de un sistema de proyectores en una línea continua a lo largo de la línea axial principal de cada nave, en lugar de un sistema convencional de nave alta, pero la consideración más importante fue la facilidad y el costo de la instalación y su mantenimiento, y se cumplio con todos estos requerimientos

Se prefirieron las lámpas de sodio de alta presión y se montó la lámpara lineal (SON.TD) en proyectores "Haline", con lo cual se redujeron aun más los costos de la instalación.

Las pruebas de factibilidad y el empleo de modelos mostraron que las dos hileras de proyectores, montados adosados por parejas en la pasarela central, a intervalos de 4 m. y a una altura de 15 m., darían una iluminación uniforme de 350 lux colocando alternadamente tres lámparas con una elevación de 26° y una 4° de la vertical. Se hicieron unos cálculos cuidadosos para determinar los niveles de resplandor directo y reflejado y se vió que éstos estaban por debajo del máximo sugerido por la presente norma de la C.I.E.

Finalmente, se efecturaron las pruebas de las instalaciones a plena escala y éstas indicaron que el sistema era extremamente satisfactorio y en muchos aspectos mejor que en sistema convencional de luminarias industriales montadas en naves altas.

PRUEBAS DE VIBRACIÓN PARA LÁMPARAS DE VEHÍCULOS 21
D. Brown y M. J. Vuliamy

Las lámparas de automóviles están sometidas a la máxima vibración. Las frecuencias casuales de vibración halladas en los vehículos oscilan entre 20 y 400 Hz. y resultan de la irregularidad de las superficies de carreteras y de la vibración impartida por el motor y la caja de cambios.

Hasta hace poco tiempo se realizaban las pruebas por cuenta de los usuarios, a menudo con equipos muy primitivos. Los filamentos de las lámparas de 24V son por naturaleza más débiles que los de las lámparas de 12V, pero al emplear la mayoría de los vehículos pesados la más alta de estas tensiones, un método de pruebas selectivo es de gran interés, tanto para el usuario como para el fabricante.

Thorn y otros fabricantes han hecho estudios en carretera en un cierto número de vehículos y se han registrado los resultados. Esto ha constituído la base para la creación de equipos vibratorios de pruebas. Se emplean tres métodos: la prueba de barrido en frecuencia, la prueba de vibración casual de banda ancha y la prueba de barrido de vibración casual de banda estrecha.

Se hallan ahora disponsibles unos vibradores de gran potencia y precisión, con los cuales se prueban de 20 a 25 lámparas a la vez, concluyendo con una prueba de impacto. Se están efectuando en la actualidad pruebas de intercambio por los fabricantes europeos para establecer unas normas internacionales.

Las pruebas han dado como resultado la modificación del diseño de lámparas para ofrecer una mayor seguridad en servicio y esto redunda, evidentemente, en beneficios para el usuario y el fabricante

EL DESARROLLO DE EFICIENTES FUENTES DE LUZ 25
M. A. Cayless

La producción económica de luz a partir de la electricidad ha sido objeto de una investigación y desarrollo de gran intensidad desde que Swan y Edison produjeron las primeras lámparas incandescentes prácticas en el otoño de 1878 y en la primavera de 1879, respectivamente. Desde entonces, se ha mejorado constantemente la eficacia de las lámparas y hoy en dia, mientras que pueden lograrse eficacias próximas a los 100 con fuentes de luz más blancas.

La duración de la lámpara ordinaria de filamento está limitada por el grado de evaporación del filamento y su emisión lumínica se reduce al depositarse tungsteno en la bombilla. La aplicación de ciclo halógeno tungsteno ha resultado en unas mayores presiones del gas, siendo por tanto posible prolongar la duración de la lámpara y permitiendo unas temperaturas más elevadas del filamento para lograr una mayor emisión de luz sin ennegrecer la bombilla. Continúa la investigación en nuevos halógenos, pero no pueden esperarse más de 50 lm/V (lumens por vatio) de una lámpara de filamento

Hasta hace unos 10 años, la mayoría de las lámparas de descarga contenían vapor de sodio o mercurio. Los tubos de mercurio de baja presión son ricos en radiación ultravioleta y si se revisten interiormente con un fósforo fluorescente adecuado podrán producir luz de cualquier color que se desee. Aumentando la presión del vapor se restringe el arco y se aumenta la proporción de luz visible a radiación U.V. La luz no tiene un color aceptable pero esto podrá mejorarse revistiendo la bombilla exterior con un fósforo fluorescente, lográndose así eficacias que se aproximan a las de los tubos fluorescentes de colores "de luxe".

Ya se ha establecido hace mucho tiempo que al aumentar la presión de vapor de una lámpara de sodio se mejora su color, pero no se ha podido lograr esto hasta después de haberse desarrollado unos tubos de descarga adecuados. La tecnología de la fabricación de tubos de zafiro y la obturación de los electrodos en los mismos ha sido verdaderamente un gran logro de los fabricantes de lámparas, pero tales lámparas se emplean ahora en gran cantidad y dan una luz de color mas caloroso, con la cual pueden distinguirse los colores y cuya eficacia es de unos 100 lumenes por vatio.

Otra forma de enfocar esto es introduciendo otros metales en el arco de mercurio para "rellenar" los huecos en su espectro. Debido a que la mayoría de estos metales es muy corrosiva, se introducen en la forma de haloides, los cuales se disocian a sus elementos en el núcleo caliente de la descarga, pero se recombinan en las partes más frías del tubo. Se producen así lámparas blancas con excelentes cualidades para la distinción de los colores, además de ser unas fuentes lumínicas muy compactas cuya eficacia es del orden de los 80 lm/V para su empleo en proyectores y equipos de alumbrado intensivo en exteriores.

El límite teórico de la eficacia de una lámpara de luz blanca es de unos 200 lm/V. Sie bien la lámpara de sodio de baja presión puede alcanzar esta cifra, su luz es de un amarillo monocromático. Las lámparas de sodio de alta presión y las lámparas de haloides metálicos podrán llegar a una eficacia del orden de los 100 lm/V.

Los fabricantes de lámparas colaboran estrechamente con la investigación que se lleva a cabo en las Universidades y Departamentos de Investigación Gubernamentales y en el futuro, esto pudiera resultar en la producción de luz por procesos que en la actualidad no se conocen o que solamente se logran en el laboratorio.

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